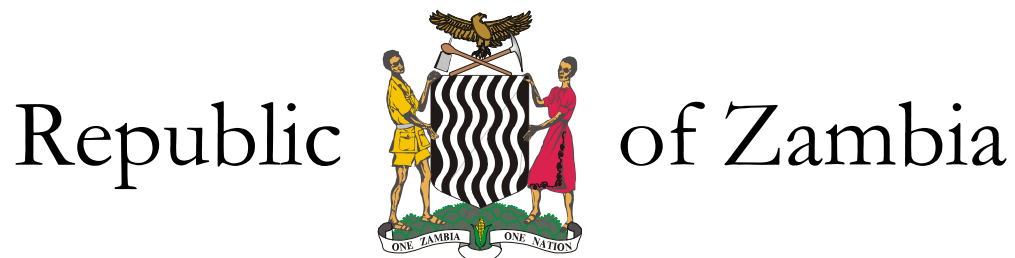


**Republic of Zambia Ministry of Education:
Assessment of Current IT Capabilities and Connectivity Assessments of
Provincial and District Offices
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Ministry Of Education

ASSESSMENT OF CURRENT IT
CAPABILITIES AND CONNECTIVITY
ASSESSMENTS OF PROVINCIAL AND
DISTRICT OFFICES

DECEMBER 31, 2003

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EXECUTIVE SUMMARY

This report presents the findings of the team commissioned to assess the information technology (IT) capacity of the Ministry of Education (MoE) in Zambia. The assessment is required to ensure that the currently installed network is reliable and sustainable and that the future expansion plans for the network are achievable.

The MoE has implemented one of the largest networks in Zambia, connecting over 250 computers in their offices in Lusaka using wired and wireless technologies. All 250 computers can access the Internet through a connection at the MoE headquarters. The ministry now wants to expand the network to include the provincial and district offices by providing computers and communication links back to Lusaka. Before proceeding with the expansion, the MoE requested this assessment to answer the following questions:

- What can be done to strengthen the current network?
- What are the best options for expanding services to the provinces and districts?
- Is there a need to switch from Microsoft to Open Source software?

A team led by a local communications consultant and an external networking and operating system consultant conducted the assessment. The team also included members from the Directorate of Planning and Information, the Examinations Council of Zambia (ECZ), and the ICT Steering Committee. The team gathered information over a two-week period through interviews with employees in the MoE offices and in the regional offices. The team also met with strategic IT based companies in Zambia. The MoE also provided the team with reports and documents relating to the objectives of the assessment.

The MoE has excellent information communication technology (ICT) in place, technology that is designed around sound networking principals. However, our team found that the network congestion can be reduced, bandwidth can be increased, and sustainability can be improved. Replacing the network hubs with switches can reduce the network congestion and improve overall network performance. The MoE can improve Internet throughput and provide live backup routing for Internet traffic by moving the Internet connection from the current 2.4 GHz radio link onto two DSL links at ECZ and MoE headquarters. This will not only increase bandwidth, but will also reduce costs.

The network cannot be sustained or expanded without addressing the shortage of skilled IT personnel within the MoE. Because Zambia, as a whole, suffers from a shortage of skilled technical people, MoE trained personnel find their new skills are in high demand and leave shortly after their training is completed. The ministry will have to outsource the technical services it requires until it can compete with the private sector. The MoE currently receives some services from external IT companies and these services must be expanded. Network monitoring systems will have to be put in place to make up for the lack of on-site staff.

The network requires a backup strategy. The ECZ has the only network with a working backup. The implementation of a reliable, scheduled backup plan is crucial to the sustainability of the network.

As the MoE improves the performance and sustainability of its network, it must subsequently promote its use. The senior management of the MoE in cooperation with the ICT Steering Committee should develop policies to increase the use of e-mail, file servers, and electronic document publication.

Zambia has the communication infrastructure in place to allow the expansion of the MoE network to most provinces and districts; however, communication in the country is expensive. The annual cost of providing a high speed connection for the nine provinces and dial-up connection for the seventy two districts would be in excess of 70,000 US\$. Providing only dial-up services would reduce the annual cost to 30,000 US\$. While the provinces and districts do not have the technical resources to support the extended network at present, outside sources for technical support, such as those presently already used in the Eastern province, are available. The regional office managers concur with the team's findings that extending the network will greatly improve the flow of communications and eventually reduce costs. The savings are anticipated to come from reduced telephone, fax, and travel costs. The MoE must recruit the active participation of their managers in the expansion process.

The MoE should continue using Microsoft software as the core of its network and desktop systems. The concerns voiced by the Academy for Educational Development (AED) and others about the licensing and support costs brought to light by a Microsoft Enterprise Agreement are based on misinformation. The MoE does not require the additional licenses and Microsoft support is not a function of the agreement. Moving to an Open Source software solution would not reduce costs and the MoE does not have the technical skills available to support the move.

The MoE network expansion plans will greatly improve communications and the development of education within Zambia. The ministry must find the resources needed to build, sustain, and improve the network infrastructure. This report provides the information required to meet these outcomes.

1.0 INTRODUCTION

In 1999, Zambia's MoE embarked upon an education reform program to increase enrollment and improve achievement among the children of Zambia. This reform program required an increase in the MoE's capacity to obtain, process, manage, and present timely information to allow the making of informed decisions. In order to reach these objectives, the MoE has established an Education Management Information System (EMIS) that provides the MoE with access to that information.

Since 1999, the ministry has implemented a local area network (LAN) within the ministry's headquarters and has expanded the network to include the ECZ, the Curriculum Development Centre (CDC), and the Teacher Education Department (TED). The network will soon include the Education Broadcasting Service (EBS) and the Lusaka Provincial Education Office (PEO). The network provides e-mail, file sharing, and a high-speed (128 Kbps) connection to the Internet.

The network was established through joint efforts between the Danish Agency for Development (DANIDA) and the American Institutes for Research (AIR). DANIDA was seeking to implement a network to assist with its programs at the CDC and TED while AIR required a network to implement the Ed*Assist program which collects and processes information from the Zambian schools. Combining their efforts into a cooperative venture allowed the network to become available to most of the MoE offices within Lusaka.

The MoE is now interested in expanding the network to the eight other PEOs and, where feasible, to the District Education Offices (DEOs). The ministry feels this expansion will greatly improve the quality and speed of information from the regional offices and would provide cost savings.

To prepare for this expansion, the MoE requires an analysis of its networks current capabilities and a review of the options available to expand the network to the provinces and districts. The ministry has, therefore, authorized the creation of this report.

The stated objectives of this report are to:

1. Assess the current IT capacity of the ministry, its current strengths and weaknesses.
2. Consider reasonable software options to ensure a stable, reasonably priced, multi-desktop, internal network.
3. Conduct connectivity assessments of two Provincial Education Offices, one along the line of rail and one outside established IT infrastructure.
4. Recommend solutions to meet the ministry's network expansion requirements.
5. Identify appropriate and workable solutions in varying geographical, topographical and level of connectivity penetration areas. Solutions should include both data and voice options.
6. Define specifications and requirements to also cover extension to the districts.¹

¹ Objectives are from AED Consultant Work Order No. (303-01-01)

The assessment was conducted by a team led by an external Canadian expert in networking, communication and operating system technologies and a local expert who understands the telecommunication and connectivity services in Zambia. The team also included members drawn from the Directorate of Planning and Information, the ECZ, and the Information Communication Technology (ICT) Steering Committee.

The team met with the ICT Steering Committee to clarify the objectives and the members were provided with reports and memos relating to the ministry's plans. The team then visited and interviewed members from the following areas within the ministry in order to collect information for the assessment:

- The Ministry headquarters.
- The Examinations Council of Zambia.
- The Curriculum Development Centre.
- The Teacher Education Department.
- The Education Broadcasting Service.
- Five Provincial Education Offices.
- Five District Education Offices.
- Two Teacher Training Colleges.
- One Teacher Resource Centre.

The team also met with representatives from USAID, Internet service providers, companies offering IT services, computer equipment vendors, and Zamtel, the main telephone access company. A complete list of the sites visited and the persons interviewed can be found in Appendix D of this report.

A questionnaire was developed for the site visits to the provinces and districts to help in gathering comprehensive information from all sites. A sample of this questionnaire has been included in Appendix E.

Information was gathered from many sources over a two-week period. This information was transcribed into a tool called MindManager from Mindjet to organize the facts into a structured and comprehensive model. This model helped the team to understand the current situation, options for future expansion, and obstacles that needed to be overcome.

Most of the information was gathered through interviews and in many cases the team was not able to verify this information through other sources. Data collection using interviews often contains errors because either the interviewer does not interpret answers correctly or the interviewee does not understand the question. As such, there may be interpretive errors in the information presented as it was left to the individual team members to determine validity of the information. The team is especially grateful to those members of the ministry who provided their insights and guidance to minimize these errors.

This report outlines methods for improving the quality and sustainability of the current network and provides the requirements and specifications to expand the network to the regional offices.

2.0 THE CURRENT NETWORK

2.1 OVERVIEW

The MoE network has the capacity to greatly improve communications. The network contains over 250 computers and over 400 users have e-mail addresses. The computers all can connect to the Internet for e-mail or browsing. Each of these 250 computers and their users can reap the benefits a network has to offer. They have the capacity to:

- Archive files to the file servers, providing a secure storage space for important documents.
- Make use of other resources such as printers, scanners or CD-writers.
- Reduce communications costs by replacing phone calls, faxes and deliveries with e-mail.
- Post and retrieve standard documents from a central repository on the network.
- Share and receive information from other users.
- Increase reliability through network backups and monitoring.
- Use programs that are too large for the workstation computers.
- Contact resources worldwide with e-mail access.
- Research any topic through the Internet.

Users who can make proper use of their computers and the network will accomplish more work, achieve better job satisfaction, and gain skills that will make them more effective in carrying out their duties within the ministry. The MoE network has the capability to provide all these benefits and more.

The assessment of the MoE's IT capacity will include the following areas:

- The current usage of the network
- The local area network
- The wide area network
- The infrastructure of the networks including:
 - Hardware
 - Software
 - Power
 - Air Conditioning
 - Security
- The human resources available to maintain the network

2.2 NETWORK USAGE

The assessment team found that computers are being used extensively throughout the ministry. Most of the offices visited had computers. Many of these were provided by donor-funded projects to be used to run software specifically for these projects. Although this has increased the availability of computer, the computers have become solely identified with the projects rather than being seen as a generic tool to accomplish many tasks. For example, computers are identified as the "BESSIP" computer or the "FMS" computer.

The team also found that although over 400 ministry users currently have e-mail accounts, the use of email is very limited. Those who do use it complain that e-mails they send to others are often not read. This lack of use is predominant at all levels within the organization.

Browsing of the Internet for information or research purposes has proved successful with those who have ventured to try it. The usage tables reviewed show that a substantial number of users are using the Internet connection for web browsing; however, a cursory examination of the web logs indicated that most usage was of a personal rather than business nature.

The use of the network to share resources has not been promoted effectively. Almost every computer has its own printer where often a shared printer would be more effective. The team found one office that had three computers with three printers attached, all sitting on two desks in an office no bigger than 10' x 15'. The office could have easily managed with one shared printer, saving valuable desk space and giving the ministry two fewer printers to maintain.

The file servers are vastly under-utilized. Everyone who is part of the ministry domain is given directories on the servers to save personal, departmental, and ministry wide documents. A survey of the servers showed that few users are making use of these directories. Saving documents onto the ministry file servers is an easy way to back up important data as well as to allow collaboration on projects. At least one user had discontinued use of the file server because they had lost their files when the server was rebuilt. Proper administration and backup procedures must be implemented to assure users of the safety of their data.

The assessment team noted that in many areas of the ministry, information was being recorded manually as well as electronically; thus the computer was providing few if any benefits to the department. The operators did not have faith in the security of the electronic data and so would not let go of the manual methods.

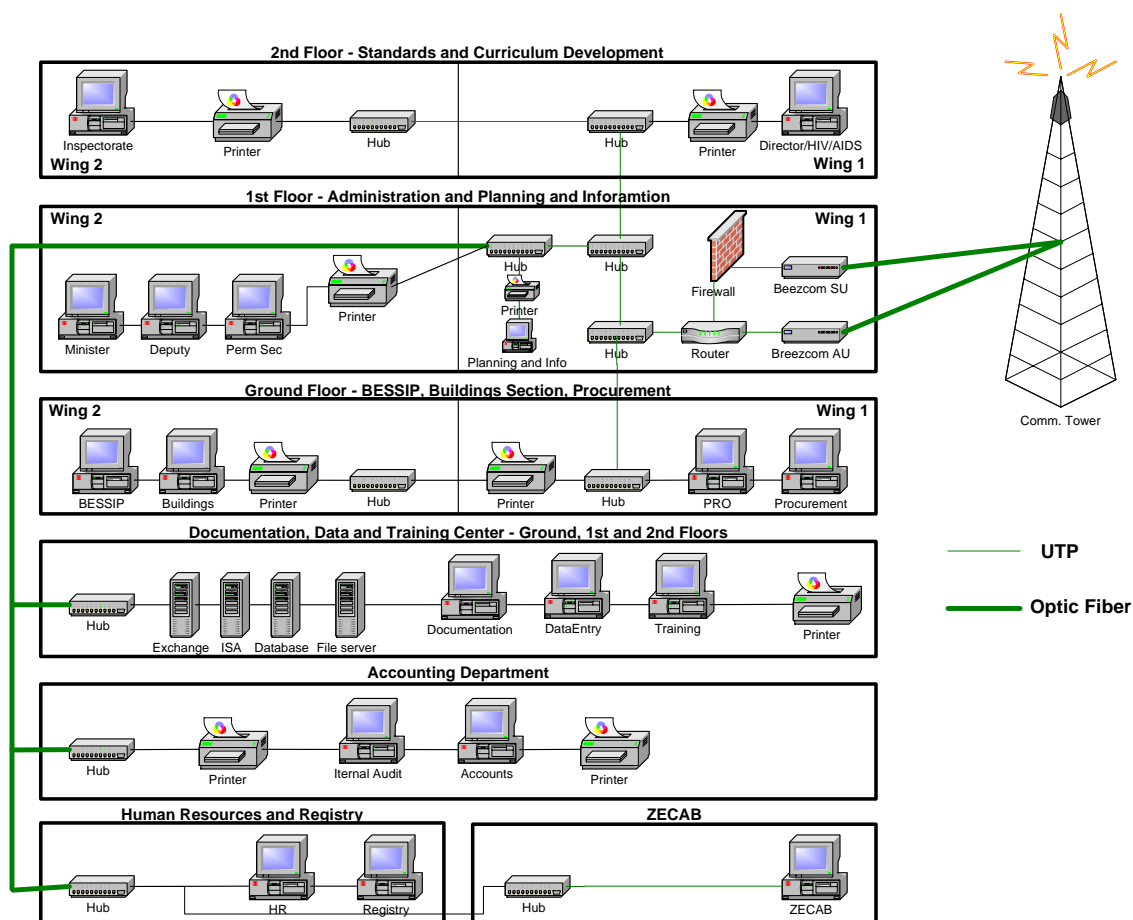
Network-based applications are being run on the servers, and these are using the network to its advantage. The Sun Financial System is being run over the network and it is hoped that the network expansion will allow its use in the provinces to manage donor funding. The ministry has also implemented the corporate version of Symantec's Norton AntiVirus, which controls the scanning for viruses and updating of the virus definitions through the network from a central location.

Some attempts at implementing a network-based application have not been successful. The group in charge of the Ed*Assist project had put their Microsoft Access-based application onto the application server. They found that the application's reports were taking significantly longer to run than when the application was run on a workstation. The application was taken off the server and put back onto the workstation.

2.3 LOCAL AREA NETWORK

The LAN within the MoE headquarters encompasses multiple floors and buildings in the headquarters compound. All the computers and network devices belong to a single Windows domain and are all part of the same network. Computers in the departments are connected to the network through strategically placed local 3Com hubs. These hubs are connected to with Cat 5 unshielded twisted pair copper and fibre optic cabling forming the backbone between departments. Figure 1 provides a pictorial representation of the network topology within the headquarters.

Figure 1- Ministry of Education Local Area Network



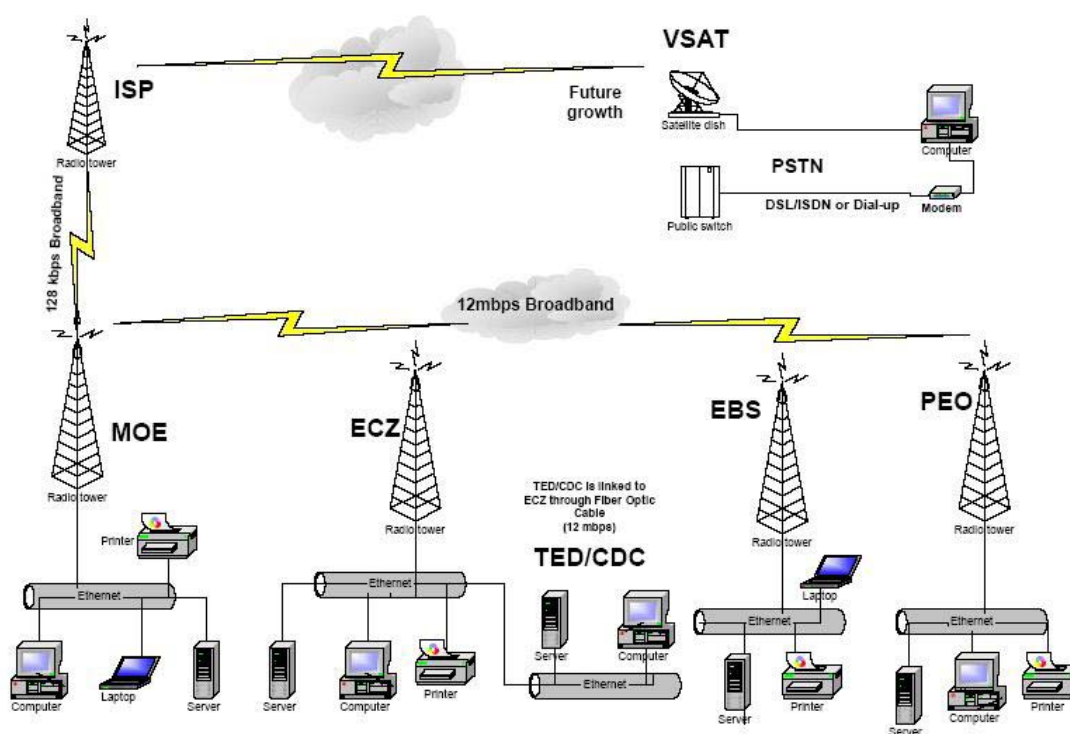
All the hubs are operating at 100 Megabits per second and are located inside secured network cabinets to prevent tampering. The temperature of the air inside the cabinets is warm and fans have not been installed. The cabinet containing the Breezecom wireless equipment, the Cisco router, and the Pix firewall seemed especially warm. The cabinet door is being left open to allow air to circulate and cool the equipment. The radio that was used to provide access to the Internet Service Provider was located in this cabinet. This radio had failed prior to the assessment team's arrival. Plans have already been made to obtain and install a fan for this cabinet. The cabinet is located in an unoccupied room and the room is kept locked at all times.

The network can become congested causing delays for the people using it. This occurs because all 150 computers are broadcasting their packets through the entire ministry. The hubs used for connecting the equipment to the network do not segment the network to localize traffic.

2.4 WIDE AREA NETWORK

The WAN connects the MoE headquarters with the ECZ, the Tender Board, and CopperNet, the Internet Service Provider (ISP), through 2.4 GHz. radio frequency transmissions. The Teacher Education Department (TED) and Curriculum Development Centre (CDC) are connected to the ECZ through a 100 Mbps fibre connection. They are routed to the MoE headquarters through ECZ's wireless link. The MoE headquarters will soon be linked to the Education Broadcasting Service and the Lusaka PEO through separate 2.4 GHz radio frequency transmissions. The wireless link to CopperNet, communicates at 128 Kbps, while all other wireless links communicate at 12 Mbps. Figure 2 provides a pictorial representation of the WAN. In the figure, the potential future growth to the other provinces and districts is also included, although the VSAT connection is only one of a few possible options.

Figure 2 - Ministry of Education Wide Area Network



All the traffic to the Internet is transmitted through the radio tower located at the MoE headquarters. Traffic from TED or CDC travels through the fibre backbone to ECZ, then through the radio link from ECZ to the ministry and finally to the ISP via the MoE radio link. A Cisco 1700 router at ECZ and a Cisco 3620 router at the ministry's headquarters control the routing of this traffic. Traffic between the ISP and the Cisco 3620 router is monitored and restricted by a Cisco Pix 505 firewall, which protects the ministry from intruders who may try to access the ministry's network.

The ministry has also implemented a backup route to the ISP in the event that the primary link at the ministry's headquarters fails. The backup link is through a 128 Kbps 2.4 GHz. radio link on the ECZ radio tower. If the primary link fails, the radio link at the ECZ tower is enabled and the Cisco 3620 and 1700 routers are reconfigured to reroute Internet traffic through ECZ. Only one of the 128 Kbps links can be active at a time.

Presently, Internet services are being provided through the backup link. The primary link from the MoE headquarters to the ISP failed and the traffic had to be rerouted. The switchover took more than a week to configure and during that time the ministry was without Internet access. The ISP's technicians determined that the radio at the ministry's headquarters was no longer functioning and this had caused the failure. A replacement for the radio is not available from local suppliers so it is being obtained from overseas, which entails significant delays.

One consequence of using the backup route is that the Cisco Pix firewall is no longer protecting the network from intruders. The Internet traffic is coming into the network through the Cisco 1700 router at ECZ and is bypassing the firewall. The Cisco 1700 has been configured to hide all available ports from the Internet and a port scan performed by the assessment team showed no apparent vulnerabilities. The network could still be open to denial of service or other such attacks.

2.5 NETWORK INFRASTRUCTURE

Most of the computer equipment found within the ministry is relatively new and of good quality. The workstations are name brand equipment and are generally more than adequate to perform the tasks required. The MoE headquarters has five servers all of which use the Microsoft Windows 2000 Server operating system. These five servers are identified as follows:

- **The Microsoft Internet Security and Acceleration (ISA) Server** – The server that will provide the ministry's web presence, provide control of Internet access and cache Internet requests, improving speed.
- **The Backup Server** – The server that will provide the backup services for all the other servers in the ministry.
- **The Exchange Server** - The MoE's primary domain controller (PDC). It also manages all the e-mail and the directory services using Microsoft Active Directory. It also manages the Symantec AntiVirus Corporate Edition software.
- **The Application Server** – The server hosting the main MoE applications including:
 - Sun Financials running under Microsoft SQL Server
 - Financial Management System (FMS) running under Microsoft Access
 - The Zambia Education Capacity Building Program (ZECAB).
- **The File and Print Server** - The server used for safe storage of the user and department files and used to provide and control access to the network printers.

The ISA server is an older model Compaq server configured with two 17 GB hard drives providing 34 GB of disk space. The server does not currently provide many services for the MoE. Microsoft's ISA server software can provide Internet security, web caching,

and a web presence. The ministry is using the Cisco routers and Pix firewall to provide their Internet security. The ISP provides the caching and the ministry does not yet have a web presence or an Intranet. The ISA server is providing information on sites visited by some of the users but when the assessment team required access to the Internet, they were able to configure their computers to use the Cisco router directly, bypassing the ISA server completely.

The backup server is not currently being used. It is an older IBM server with five SCSI hard drives of unknown capacity. Only one of these hard drives was connected to the SCSI controller and the server had crashed just prior to the assessment team's departure. The tape backup unit had not been acquired for the system although one was anticipated shortly. The backup server is located in a separate building from the other servers. The backup process, as explained to the assessment team, was as follows:

- The other four servers would have programs running on them that would copy files across the network onto the backup server.
- The backup server would then back up the entire backup server onto removable media using backup software from Veritas.

The three other servers are new Compaq Proliant model ML530's with twin 3.0 GHz processors and three 36.4 GB hard drives. These drives are configured in a RAID 5 configuration providing a total of 67.8 GB total disk space per server. The RAID configuration provides the systems with the capability of continued operation with no data loss in the event of a single hard drive failure. These drives are hot swappable which allows a failed drive to be replaced and automatically re-built without having to shut down the servers. These servers are powerful, well-configured systems.

The ministry has more than enough printers to meet its needs. The printers are typically late model Hewlett Packard or Lexmark laser printers many with built-in network connections.

The network cabling within the ministry has been completed professionally with Category 5 cabling throughout and all terminating in locked network cabinets. Connections to workstations are provided through wall-mounted jacks and patch cables as per industry standards.

The ministry experiences power outages, brownouts and power surges that can cause problems with computer systems. The ministry has provided filtered and backup power to all of its servers and most workstations with uninterruptible power supplies (UPSs). The hubs and routers are not connected to UPSs; however, the ministry does have these available and will be installing them shortly. The team also observed many instances of kettles, fridges, and other high power-drawing devices plugged into the same outlets as the UPSs or computers, which can create additional problems with equipment.

All of the operating system and office automation software use Microsoft products. This is true throughout the ministry with the exception of a few UNIX based systems at the ECZ. The service packs have been applied to the servers, but there are no procedures in place to ensure that patches and updates are applied on a regular basis. Symantec AntiVirus Corporate Edition is being used to keep the ministry servers free from computer viruses. It controls the scanning and updating of viruses on all configured workstations from a single server that provides centralized monitoring and quarantining of viruses. An investigation of the software logs showed that the virus engine and

definitions had not been updated since it had been last installed. This was due to a configuration error in the program's setup. This was corrected during the team's visit. The monitoring software discovers and quarantines at least six new viruses in the ministry every day. It is not known whether every computer in the network is being scanned.

The event logs and other system logs of the servers are not being monitored on a regular basis. The server rooms are air-conditioned and kept cool enough to ensure the proper operation of the equipment. All are kept locked when not in use and the distribution of keys is kept to a minimum. All offices are also locked and many have metal bars to prevent a forcible entry. The compounds have 24 hour a day security service.

2.6 HUMAN RESOURCES

The largest risk to the continued success of the MoE's IT capabilities is the lack of people with technical skills available to support the network.

The ministry faces a severe shortage of skilled IT professionals who are required to manage, maintain, and expand the network. The MoE's Information and Statistics organization chart has many vacancies that it has been unable to fill. Skilled workers are in short supply and demand is growing. Educational institutions, such as the University of Zambia, only produce a handful of graduates from their Computer Science programs each year. The Technical Education Vocational Entrepreneurship Training Authority (TEVETA) is a government agency responsible for accrediting technical training institutions in Zambia. There are a number of these accredited institutions, but they suffer from a lack of staff and equipment. Government funding has ceased and the institutions are struggling to survive. These institutions cannot solve the skills shortage. The telephone poles around the ministry are covered with flyers from private training companies offering IT accreditation. The quality of the training is doubtful and prices are high. With few IT professionals being trained through public institutions, the ministry has been training its own personnel. Once the training is complete, these people often leave the ministry for the private sector where the salaries are greater because of the high demand.

Projects, such as the EMIS project, have resorted to hiring their own technical resources using project funds. The salaries from project funds are not restricted by the ministry guidelines and can compete with the private sector for the skilled personnel. The EMIS project and others have outsourced ongoing maintenance to external service companies also paid with project funds.

The EMIS project has signed a contract with Authorized Support & Consultancy Services (ASC Services) to provide technical support for the headquarters' servers and the network. The contract consists of a 20-hour block of time purchased at 60.00 US\$ per hour. This 20-hour block is purchased every quarter. The ministry calls ASC Services for support on an as-needed basis. Time used outside of the contract is billed at 75.00 US\$ per hour. ASC Services have Microsoft certified and Cisco certified engineers on staff in Lusaka. ASC are also authorized service centres for HP, Compaq and other equipment suppliers. They have offices in Zimbabwe where more extensive expertise is available and will soon be opening an office in Kitwe to service contracts in that area.

The EMIS project has also contracted a company called Instant Systems to provide preventative maintenance to the computers in the Eastern PEO and the seven DEOs.

The contract requires a site visit once per quarter to address computer issues brought forth by management, ensure proper operation, check fans, clear out the dust and update the computers with the latest patches. The maintenance includes servicing of desktops, laptops, HP laser printers, and assessment of the UPSs. The cost of this contract is K5,020,000 per quarter or approximately 1000 US\$.

The Danish Agency for Development Assistance (DANIDA) has contracted with a company called PC Consultants to provide two full-time technicians to support the needs of the users at the TED and CDC. These technicians solve minor technical issues, repair equipment, and ensure the continued operation of the computer systems. For any problems beyond basic maintenance, the technicians require outside technical assistance.

Very few computer users are capable of doing more than the specific tasks assigned to them. Some can use Microsoft Word and others Excel, but the level of knowledge of these applications is very limited. Often, the knowledge that has been developed has happened through project funded IT capacity development programs. These programs tend to have a narrow focus and only develop the skills needed to meet the project requirements.

The EMIS project, funded by USAID and working through AIR, has started to address the lack of compute skills with the installation of a training room in the ministry headquarters. The training room is spacious, air-conditioned, and completely self-contained eliminating distractions from outside sources. The training room has the capacity to train up to twenty students each with their own new Compaq workstation. The workstations have all been incorporated into the ministry network and have access to the Internet. The workstations have the complete Microsoft Office Suite installed including Word, Excel, PowerPoint, Access, and Outlook. A large capacity network laser printer is available in the classroom for student use. The EMIS project has also provided comfortable desks, chairs, whiteboards, and a video projection unit. The teacher has a workstation to assist with the delivery of the lessons.

The EMIS project has used this training room to deliver training on the Microsoft Office Suite fundamentals and Ed*Assist to provincial and district personnel from Eastern and Southern provinces and selected individuals from Northern and Western provinces. Several of the offices were visited to determine the impact of this training and the general impression was that the personnel are using the computers at a basic level, but a lot of work is still being done manually. In one instance, a spreadsheet was being used to record statistical data, but the columns were added on a calculator and the number typed in rather than using the sum() function of the spreadsheet. The visit also found that there was at least one energetic individual at each site who was excited about the introduction of the computers into the offices.

2.7 EXAMINATIONS COUNCIL OF ZAMBIA

The Examinations Council of Zambia is responsible for the preparation, registration, delivery, tracking, and archiving of the National Examinations for Grades 7, 9, and 12 throughout the country. The exams and the registers for the exams are printed at the ECZ and delivered by couriers.

The ECZ uses four servers in its operations including: two older NCR servers running MPRAS, an older proprietary version of UNIX; One newer HP NetServer server running SCO UNIX; and one new Compaq Proliant server running Microsoft Windows 2000.

- NCR Servers - are the main processing servers for the examinations system using Informix as the database.
- SCO UNIX Server - is being used as a file server and for backups.
- Windows 2000 Server - is the local PDC for the ECZ domain. It runs Exchange for e-mail and is shared with MoE headquarters. It is also running SQL Server for the Census Application.

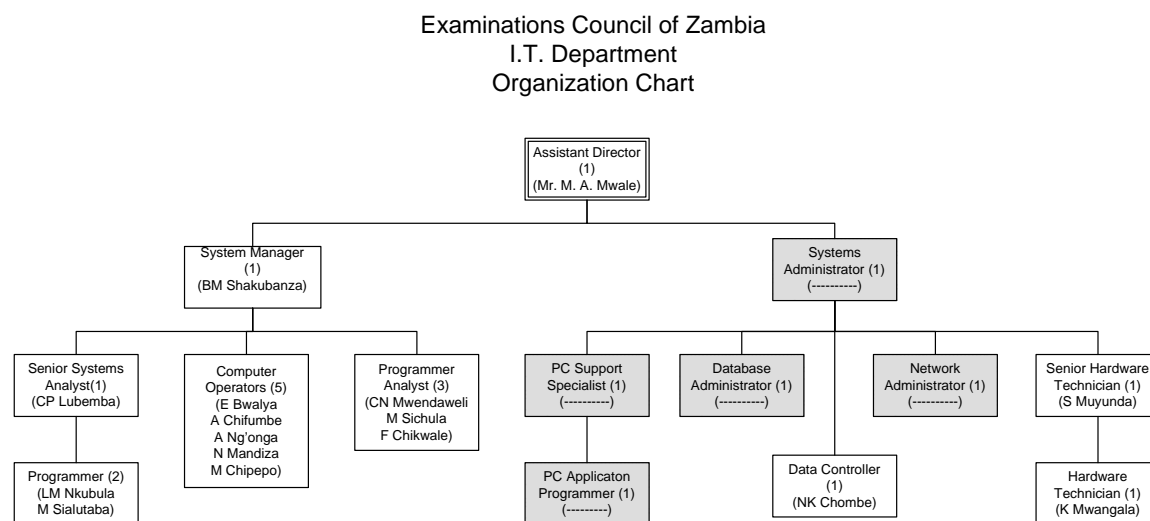
The NCR servers do not have enough disk space to store the databases so the SCO server is used to store the files. The application running on the NCR servers accesses the files through an NFS connection. The SCO server was originally purchased to replace the aging NCR servers, but the ECZ has not been able to obtain financing to purchase the required Informix license.

All of the ECZ servers have tape drives and these are used to back up the data, daily.

The ECZ also has 40 computer workstations for their users running Windows 98, Windows 2000, and Windows NT Workstation.

The staffing positions defined for the IT department of the ECZ provide for a well-managed technical organization, but there are many vacant positions. Figure 3 – ECZ Organization Chart shows the all the positions in the department.

Figure 3 - ECZ Organization Chart



Shaded boxes denote vacant positions and there is an indication that other positions may soon become vacant. There is a noticeable difference between the programming side of the organization, which has no vacant positions, and the systems administration side, in which 5 of the 8 positions are vacant. This discrepancy is likely caused by the specialized skills on the programming side. The demand for programmers with skills using Informix and Pascal is not as great as the demand for system administrators.

2.8 TEACHER EDUCATION DEPARTMENT AND CURRICULUM DEVELOPMENT CENTRE

The Teacher Education Department and the Curriculum Development Centre share office space near the ECZ. The Teacher Education Department provides support for the Teacher Training Colleges and also provides the in-service training for the teachers. The Curriculum Development Centre creates the curriculum, textbooks, and supporting documents that are provided to the schools for the teachers and students.

The two departments share a Windows 2000 based file server that provides file and print sharing services and is a Backup Domain Controller (BDC) within the ministry network. The offices are connected to the ministry WAN through a fibre connection to the ECZ. The BDC allows users to log into the network and continue to get access to resources, should the link to the PDC at the ministry's headquarters fail.

The Windows 2000 server is a new Compaq ML 350. It does not contain a backup device and is not located in a secure area. Although it is plugged into a UPS, the outlet is being shared with a refrigerator.

The combined TED and CDC sections have 4 NT Workstations and over 20 Windows 98 machines. The department uses Microsoft Office products, such as Word, to produce its curriculums and teacher support documents. The department is also running Navision Financial software on two of its workstations.

The people within the two departments have basic computer skills usually limited to the specific tasks required by a project requirement. The hardware and network maintenance for the TED and CDC is outsourced to a company called PC Consultants.

2.9 EDUCATION BROADCASTING SERVICE

The Education Broadcasting Service develops programming for TV and radio broadcasts to provide an education to the estimated 600,000 children who are too remote an area or too poor to attend school. Data collection is a huge obstacle, the EBS has no idea what impact their project is having on education in Zambia. They estimate they have between 10,000 and 20,000 students but they have no way to verify this.

The EBS occupies a three story building in downtown Lusaka. The ministry has installed a LAN with 13 computers and 26 drops running in a Peer-to-Peer network. The EBS is waiting for funding to purchase a radio, antenna, and router to give them access to the MoE WAN, which will also provide them with access to the Internet. The local computers are all running Windows 2000 and one of the workstations is being used as a file server. The EBS users save their important files to this server and the files are then backed up weekly onto CD-ROMs. The server is kept in a separate locked room that is adequately cooled. The room lacks any lighting or windows and a flashlight is required to perform any maintenance or administration. All of the computers in the EBS are protected via APC 650 UPSs.

The personnel at the EBS are proficient in the use of computers. Computers are an integral part of their work. A project consultant is currently performing the system administration tasks for the network at the EBS. The administration was not part of his contract; however the task has fallen to him in the absence of other options. The consultant's contract expires shortly, but he does expect it to be renewed.

3.0 THE CURRENT NETWORK: RECOMMENDATIONS

3.1 USAGE

Although the assessment team found that computers are installed extensively throughout the ministry, the computers and the network are not being used to full advantage. The computers tend to be used primarily for the projects that provided them. The users should be encouraged to use the computers for word processing, e-mail, and other generic uses.

The ministry needs direction and leadership in order to make full use of the benefits afforded by the current IT capacity. The Planning and Information Directorate must develop policies to promote the enterprise-wide information communication technology (ICT). Without these policies, the system's usage will be minimal, cost savings will not be realized, resources will be wasted, and the system may ultimately fail. The ministry already has the mechanism for the creation of these policies within the ICT Steering Committee. Management must work with the committee to develop the policies and then monitor and enforce them.

The required policies identified by the assessment team are as follows:

E-mail as the primary method of communication. A policy must be developed that encourages the use of e-mail as the primary method of communication. Encouraging the use of e-mail can produce many benefits including significant cost and time savings for the ministry. E-mail can replace local and long distance phone calls, faxes, courier services and delivery of documents by ministry personnel. The transmission of e-mails incurs no additional costs beyond the current cost of the network. E-mail is less disruptive to the recipient who can choose when to respond. Responding to e-mail can involve less time than phone calls in which pleasantries are often exchanged, or faxes, which often require many attempts to obtain a usable connection.

If e-mail use is to be adopted, the line managers must take the initiative; they must insist on its use within their areas of supervision and also use it themselves when communicating with other levels of management. The Permanent Secretary has committed to sending out all her agendas through e-mail to the attendees who are to read and print the agenda prior to the meeting. Other managers must adopt similar programs to help users adopt the technology.

The network administrators must also be given the tools to monitor the usage of e-mail within the ministry. The e-mail usage reports could be correlated with each department's telephone charges to substantiate the effectiveness of the e-mail policy.

File server usage. A policy must be developed to encourage and promote the use of the file servers for the storage of information. File servers provide a method of safeguarding important information and when properly managed, allow for recovery even in major catastrophic events such as fires or floods.

The file servers must be made secure, their use promoted, and their usage monitored by system administrators. The ministry should provide managers with workshops on the effectiveness of using a file server. The workshops should emphasize the ease with which file servers can be used and how lost files can easily be recovered from backup media. This may allow some of the users to abandon the manual systems that are running in parallel to the computerized systems.

Document publication. A policy must be developed to publish documents on the servers for easy retrieval by others. Many documents can be posted including policy statements, ministerial reports, budgets, expense reports, travel reports, vacation request forms, and other widely used publications. When a new document is posted, an e-mail message should be broadcast announcing the document's contents and location. Eventually the documents should be posted to a central ministerial Intranet hosted by the ISA server where they can be easily located and accessed using a web browser.

Shared applications can also be posted in such a manner. The reporting portion of the Ed*Assist database could be posted to a common location, allowing access to information that is commonly requested. Even though the application would run relatively slowly in this manner, it would still provide the information more quickly than obtaining the information through other means.

System administration standards. The policies from the Planning and Information Directorate must define the system administration standards for maintaining the MoE computer systems. This would include standards for backups, virus scanning, security, monitoring, disaster recovery, and preventative maintenance. Such a policy would ensure that systems are available, reliable and recoverable and maintained to the same standards throughout the organization.

The policy should determine backup schedules, tape rotations, strategies for off-site storage, backup software and options. It should also define the preferred backup devices and media for all departments. Using similar devices throughout the organization allows the restoration of information onto an alternate server in the case of a disaster. A method to monitor the success or failure of backups must be defined to ensure that valid, reliable backups are being performed as scheduled.

Disaster recovery and preventative maintenance policies should define how these tasks are to be carried out and list the required resources. Key equipment must be identified and sources for replacement parts found. If significant delays can be expected in obtaining these parts, the ministry must endeavor to stock those spare parts itself. Equipment with limited life spans such as (UPSs) must be inventoried and provision made to monitor, test, and replace them when they are no longer functioning.

These standards must not only be published and incorporated into the job descriptions of those working within the ministry, but must be written into the contracts of the external service providers.

Computer and network usage. A policy must be introduced which outlines the proper use of the computer systems, the network, and the information within these systems. Access to the Internet is presently unrestricted, and non-business related use abounds. Many of these unofficial activities use up large amounts of the ministry's bandwidth, hindering others who require the use of the service. The unauthorized use will slow the system, frustrate users, and severely hamper the adoption of the network within the ministry. Unlawful use can also open the ministry up to legal actions and embarrassing publicity. In the absence of a well-written policy, the ministry has no method in place to restrict the individuals' use of the system. The ministry has already been provided with a comprehensive Internet and e-mail policy for review a copy of which is included in appendix F. It should be reviewed, adopted, published and then promoted to all users of the system. The policy and the reasons for its requirements should be incorporated into all Internet training programs. The users should sign a policy agreement and be made aware that usage will be monitored and that they will be held accountable for their actions.

Training requirements. The MoE must develop a training policy and provide the facilities to upgrade the knowledge of its employees if it wants to achieve substantial benefits from the use of computers and the network. Although the ministry has many computers located within its offices, the computer knowledge of the users is limited, often restricted to the applications for which the computer has been purchased.

The MoE should create an inventory of core skills that all users must have, and courses developed to deliver these skills. Courses in word processing, spreadsheets, and other applications have already been created and delivered to PEO employees. These courses should be evaluated to ensure they meet the core requirements and then be made available to ministry employees on a regular basis. Certificates for completion of these courses can be awarded and added to the staff member's personnel records. The curriculum for these courses should also be posted on the servers and made available to the Teacher Training Colleges and the Teacher Resource Centres, so that these organizations can implement their own training programs.

Courses should be developed to train the system administrators. These courses should focus on the importance of backups, the proper procedures, methods of monitoring, preventative maintenance, and the many other facets of the job that keep systems running smoothly and efficiently. As the network expands out to the provinces and districts, this training will be necessary for both the internal and external administration staff.

The ministry has a well-equipped training room that can be used more effectively. There are many short courses that could be delivered during lunch hours or after work that would be of interest to the users and would benefit the MoE. These could be held informally once per week. The curriculum, once developed could be posted on the servers for others to use in other training facilities. Possible topics for these classes could include:

- What to do when your computer won't turn on.
- What to check before calling for help if you can't print, see file servers or get to the Internet.
- Basic computer maintenance.
- How to use e-mail: send, receive, reply, forward, attachments, and folders.
- Saving documents to file servers. Recovering lost documents.

- The safety of file servers. How the data is being backed up.
- The use of templates for standardization of ministry documents.
- Including graphics, charts and tables in word processing documents.
- Simple PowerPoint presentations.
- Using the Internet for research
- The Internet usage policy and monitoring.
- Updating your operating system software.
- Checking your system for viruses and making sure you are protected.

Many other ideas can be added and the courses should be repeated on an ongoing basis.

Data collection. A policy must be developed to coordinate the collection of data within the MoE. The collection, processing, and dissemination of information and decision-making are at the core of the MoE's Education Management Information System. The need to quickly and accurately collect and disseminate information provides the rationale for expanding the network into the regional offices. Thus, there is a need to develop policies which:

- Rationalize data collection processes between the different departments in the ministry and the regions so that information is collected only once from its source and is then shared with others who require it.
- Improve feedback to persons who collect the raw data so that they can appreciate the importance of accuracy and timely provision of information.
- Establish standardized databases at the provincial level for the collection and reporting of data. The data collection process could be implemented through such applications as a distributed Human Resource Management System.
- Establish a method for information sharing and collaboration such as through an Intranet.

Telephone usage. A policy must be implemented and enforced to ensure that telephone usage is not abused and the lines stay active. The assessment team noted that in many provinces and districts, the offices either did not have access to a telephone or its use was restricted to receive-only. The telephone company had resorted to this measure to recover overdue telephone accounts. The overdue accounts were caused by management's unwillingness to implement and enforce a policy that would make employees accountable for the use of the ministry's telephone system. The lack of an enforced policy created sizeable bills that the office was unable to manage. Central province is the only province in which the PEO has all three of its telephone lines working and every district has at least one telephone line working. The telephones are working in this province because the Provincial Education Officer enforces a strict telephone usage policy. His policy makes those officers with telephone service responsible for the charges on that line. The officers are held personally responsible for the excess charges. This policy is enforced.

Technology can be used to enforce accountability, but the funding required could be put to better use if management were to implement and enforce a usage policy. If this is not possible, then there are several options available:

- Zamtel, the state owned telephone service provider, is embarking on a new policy where all phone calls must be pre-paid, similar to that which is now required for cellular calls. Cards are purchased which have a number, which must be entered prior to making a call. The policy is being implemented in Lusaka and Livingstone on a trial basis and may be implemented in all areas that have digital service. The rural provinces are still served with analog switches, so the pre-paid service cannot be implemented in those areas.
- Zamtel also can require the entry of a security code prior to making any telephone call. Zamtel tracks the calls made using the security codes and the monthly telephone bill provides a breakdown of calls made by the code. The breakdown would give management the ability to easily hold each user responsible for the calls made using their own personal code. This service is also only available in areas that have a digital telephone service and so the solution would also not work in the rural provinces.
- Telephone systems can be purchased and installed that require the entry of a security code before a call is made. The systems could also track the phone calls made by a user's code and could hold them responsible for their calls. The telephone system would have to be kept in a locked cabinet or room, which would prevent unauthorized users from circumventing the system. The system would work in the rural areas and would track the calls by security code.

Organization presentations. The MoE should develop a short presentation on the network capabilities to sell the network to the organization. The presentation should include:

- Technology the ministry currently has in place.
- Benefits the technology can provide.
- Savings that can be realized.
- How the technology can be used.
- Uses for the technology.
- Future expansion plans.

3.2 LOCAL AREA NETWORK

The network cabinets should be equipped with fans to provide air circulation across the equipment removing the excess heat, which can cause equipment failure. The cabinets have the ability to install a fan unit without further modification. A quality three-fan unit can be purchased for under 140.00 US\$, although a single fan, positioned properly, could provide enough cooling for these cabinets at a significantly lower price.

The 3Com hubs should be replaced with switches to reduce the congestion within the network. When a hub receives packets from a device it broadcasts the packets to all of its ports. If one of its ports is connected to another hub, that hub in turn broadcasts the packets to all of its ports and so on. A switch builds an internal table of the hardware addresses of the equipment connected to its ports. It only directs packets from the port it is received on to the port to which the packet is addressed. Other packets involving the same switch's other ports can transmit at the same time and as long as they involve equipment on different ports, never affect each other. In this way, the network traffic through a switch is kept localized and congestion is minimized.

A 3Com Superstack 3 Baseline 10/100 switch with 24 ports can be purchased for about 220.00 US\$ within the continental United States. The Superstack switch is a rack mountable device that would fit into the current network cabinets. If the hubs have to be replaced on a graduated basis, the hubs with connections to the fibre backbones should be replaced first to localize the traffic.

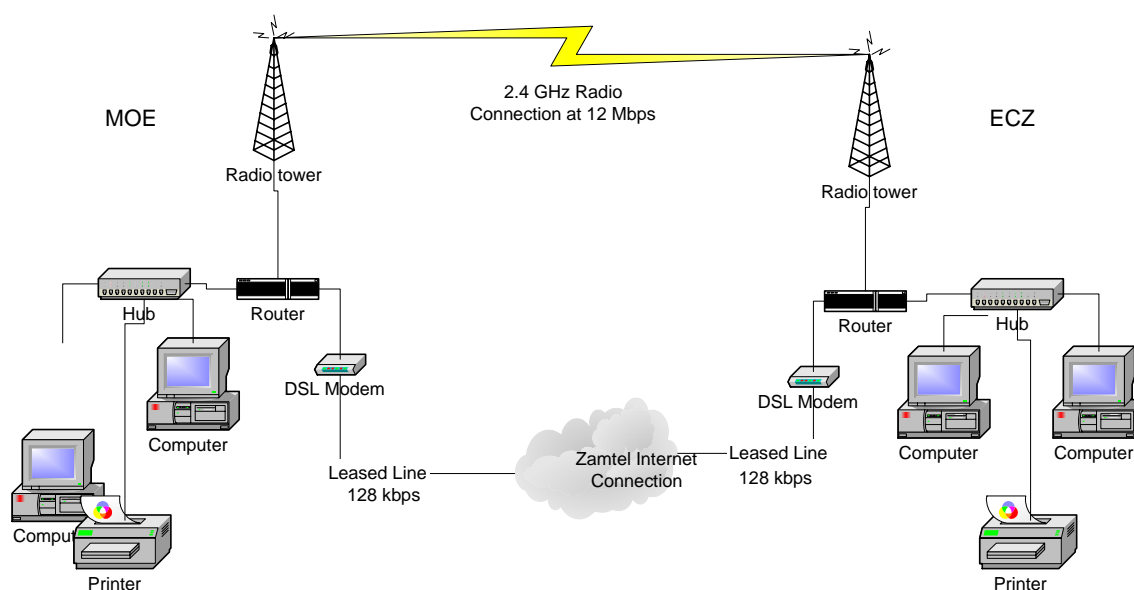
The LANs located in the other areas of the ministry are also using hubs and would also benefit by replacing the hubs with switches. For smaller locations, a 3Com Office Connect 10/100 16 port switch could be used in place of the 3Com Superstack switch. It lacks the capability to be mounted in the network cabinets, but can sit on a shelf. The Office Connect switch sells for about 60.00 US\$.

The replaced 3Com hubs could be used within the PEOs, as the network traffic would be very minimal in these locations.

3.3 WIDE AREA NETWORK

The assessment team recommends that the ministry change its Internet connectivity strategy. ADSL connections across leased lines are available in the Lusaka area from Zamtel. These lines are stable and are not affected by excessive rains in the ministry's headquarters or ECZ locations. The topology proposed for using the leased lines is shown in Figure 4 - Proposed Internet Connection.

Figure 4 - Proposed Internet Connection



The ministry should implement a 64 Kbps link at the ministry's headquarters and a second 64 Kbps link at ECZ. Both of these links would be live concurrently, providing Internet access to different portions of the network. The ministry's headquarters connection would provide connectivity for itself, the EBS, and the Lusaka Provincial Education Office. The connection at ECZ would provide connectivity for itself, the CDC, and TED. Internet traffic from each of these locations would not have to travel across the radio link allowing the bandwidth to be used for other applications.

Both routes provide a live backup route for the other in case of equipment failure. The routers could be configured to automatically reroute traffic if the link to the Internet fails at their end. The automatic routing would happen without any user intervention. Should one of the routers fail, the DHCP server could be modified to broadcast the new default route to the workstations. The backup routing also requires no action on the part of the ISP, which appears to be the weakest link in the current strategy.

The proposed connection using ADSL over leased lines using the two 64 Kbps connections would provide a savings of over 6000 US\$ per year over the current connection provided by CopperNet. The costs of the CopperNet connection were given at 17,000 US\$ per year and the annual cost for a 64 Kbps connection for the two sites is 10,800 US\$ as shown in the chart in figure 5 – Cost Comparison of ADSL Connections. Should the ministry require more bandwidth in the future, it could be easily upgraded to 128 Kbps at each site for an annual cost of 21,600 US\$ per year. The MoE could upgrade a single site to 128 Kbps leaving the other at 64 Kbps for an annual cost of

16,200 US\$ per year, still less than the price the MoE is currently paying for its wireless connection.

During the team's meeting with Zamtel, the Managing Director indicated that he was open to discussing an E-rate for the ministry's connectivity plans which would result in further savings.

Figure 5 - Cost Comparison of ADSL Connections

| | 64 Kbps at each site | | 128 Kbps at each site | |
|------------------------------------|----------------------|-----------------|-----------------------|--------------------|
| | One Time Costs | Monthly Costs | One Time Costs | Monthly Costs |
| 4 DSL Modems | \$500.00 | | \$500.00 | |
| Additional Pix 506E Firewall | \$1000.00 | | \$1000.00 | |
| Monthly Leased Line Costs | | \$100.00 | | \$100.00 |
| Monthly Internet Access Costs | | \$350.00 | | \$800.00 |
| Total Monthly Costs per site | | \$450.00 | | \$900.00 |
| Monthly Cost for Both Sites | | \$900.00 | | \$1800.00 |
| Annual Costs for Both Sites | | \$10,800 | | \$21,600.00 |
| Total One Time Costs | \$1500.00 | | \$1500.00 | |

The fixed costs for this implementation of 1500 US\$ include the costs of purchasing four DSL modems, assuming that the ministry would have to provide the modems at each end of the leased line for both locations. ISPs will often provide the DSL modems at their end of the connection. This may or may not be the case with Zamtel. The costs also include a Cisco Pix 506E firewall to ensure that both connections are protected from intruders, denial of service attacks, and other security risks. Cisco does not have a Pix 505 model referenced on its site at the current time and so the 506E was chosen as a model with similar features. The Cisco Pix 505 is the model currently being used at the MoE.

The current contract with CopperNet expires in February, 2004. The ministry should endeavor to have the replacement system in place before the contract expires.

The replacement of CopperNet with leased lines would also make redundant the radios and antennas that are currently being used to provide Internet access. The two radios and antennas could be used to provide the planned connections to EBS or the Lusaka PEO, if these connections have not been implemented before February of 2004. Not having to buy two new radios should offset the fixed costs required to implement the DSL solution.

The signals from multiple antennas on the ministry's antenna mast can be channeled through a single radio using a splitter device. The use of the splitter could eliminate the

need for multiple radios and would provide further cost savings. It should be noted, however, that the signals coming from a single radio would be broadcast through all antennas and may reduce the bandwidth.

3.4 NETWORK INFRASTRUCTURE

3.4.1 BACKUPS

The ministry must immediately implement a proper backup solution at the ministry's headquarters. The ministry cannot move forward to increase the reliance on these servers without ensuring that the information can be recovered in the event of a system failure. The backup solution should consist of the following:

- A tape backup unit with capacity to backup the information of all the servers on a single volume.
- Tape backup units, which allow the booting of a system from a tape. HP calls this feature One Button Data Recovery (OBDR).
- DAT tapes similar to those currently being used to back up the ECZ servers. Using the same media will give the ministry the ability to exchange information or restore information on other servers in the event of a disaster at either the headquarters or the ECZ.
- Enough tapes to provide a rotation schedule that ensures the ability to retrieve data for at least six months. A backup that is scheduled for Monday to Friday Backups would require 15 tapes. This would provide one tape for every Monday thru Thursday (4 tapes), one tape for every Friday of the month (5 tapes), and one tape for the last day of every month for six months (6 tapes).
- Backup software that can provide a valid, verifiable backup of the systems. The ministry has chosen Verities Backup Exec as its backup software. This is an excellent choice for Microsoft Windows Server systems. The software can provide a bit level verification of the information on the backup media, comparing it with the live data, ensuring a valid backup was completed. The ministry should ensure that it also purchases the following options in conjunction with the Veritas software:
 - Advanced Open File Option – Ensures that files in use by other programs are backed up
 - Agent for Microsoft Exchange Server – Exchange server cannot be reliably backed up without this option.
 - Agent for Microsoft SQL Server – Simplifies the backup and restore of SQL Server. SQL Server can be backed up if the database contents are dumped out to a backup file using the utilities available within SQL server prior to the commencement of a tape backup. This significantly increases the time required to restore the database.
 - Intelligent Disaster Recovery Option – Allows the quick recovery of a system from a bootable tape, CD-ROM, or diskettes enabling restores from the last complete backup. Without this option, the administrator would have to install the operating system, the hardware drivers for the tape backup unit, and the backup software in order to restore from the backup media. This significantly increases the time required to recover a system.

- Agent for Remote Backup of Windows Servers – Allows the backup of Windows servers through the LAN. This software resides on the remote server and is required if the backup is to back up these remote servers directly. The ministry could copy the files to the backup server with an automated process to then back up these files off the local drives.

The backups should be configured to print out the status reports of the backup and additionally e-mail them to the person responsible for monitoring the systems.

The sample costs of such a system would be:

| Qty | Description | Ext. Price |
|-----|---|------------------|
| 1 | HP Storage Works DAT 72 External Tape Drive | \$1250.00 |
| 1 | Adaptec 29160 SCSI Controller | \$450.00 |
| 20 | HP DDS 5 72 GB (compressed) Tapes | \$700.00 |
| 1 | Veritas Backup Exec for Windows Servers | \$595.00 |
| 1 | Advanced Open File Option | \$695.00 |
| 1 | Agent for Microsoft Exchange Server | \$995.00 |
| 1 | Agent for Microsoft SQL Server | \$995.00 |
| 1 | Intelligent Disaster Recovery Option | \$495.00 |
| 1 | Agent for Remote Backup of Windows Servers (3 Pack) | \$695.00 |
| | Total | \$6870.00 |

Prices listed here are suggested list price in US\$ for the continental United States. Prices can be negotiated with a vendor to obtain much better pricing, especially for a complete package.

The ministry should also prepare a disaster recovery plan as part of the backup strategy.

3.4.2 SPARE PARTS

The MoE should keep spare parts for the critical servers in stock. If this is not possible the stocking of the parts should be part of the support contract with the MoE's IT partners. If the parts for the servers are not available through local channels it can take up to a month to find replacements. A server could be out of service until the replacement is found. The ministry should have the following spare parts for the critical Windows 2000 Compaq Proliant ML530 servers:

| Part Number | Description | Price |
|-------------|--|-----------------|
| 231782-001 | Power supply, hot plug, 600 W. | \$275.00 |
| 161657-001 | Redundant drive fan, hot plug, 92 mm. | \$55.00 |
| 122225-001 | CPU and I/O fan, hot plug, 5 inch | \$60.00 |
| 177986-001 | 36.4 GB hot plug, wide ultra3 hard drive 10K rpm, 1 inch | \$465.00 |
| | Total | \$855.00 |

The prices are in US Funds, from a US supplier and do not include shipping, duty and taxes. All the prices quoted are for new parts, although refurbished are available at a reduced cost.

3.4.3 UNINTERRUPTIBLE POWER SUPPLIES

The ministry should install the UPSs it currently has in stock to protect the network hubs and routers.

The MoE should test all of the UPSs to ensure they are offering the protection they were purchased to provide. Many of the UPSs are more than three years old. The batteries for UPSs are designed to last between three and five years. These batteries need to be tested to ensure that they are still functional and those found faulty should be replaced. Replacement batteries for the most commonly found units in the ministry are priced as follows:

| APC UPS Model | Battery Model | Price |
|----------------------|----------------------|--------------|
| Back-UPS 600 | RBC3 | \$52.00 |
| Smart-UPS 650 | RBC4 | \$50.00 |
| Smart-UPS 700 | RBC5 | \$60.00 |
| Smart-UPS 1000 | RBC6 | \$125.00 |

The replacement costs are minimal compared to the damage that can be done to the equipment and data through power failures. Replacement battery model numbers and costs for other APC UPSs can be found on the APC website at http://apc.com/tools/upgrade_selector/index.cfm.

The MoE should use the UPS monitoring tools in all locations where it is available. Most of the UPSs have the ability to be monitored using software that is shipped with the equipment. The monitoring tool can detect the load on the batteries, the duration the batteries will last in the event of a power failure and whether the batteries need replacing. The software will also shut the servers down gracefully in the event of an extended power outage. These UPSs can be monitored from a single location through a console on one of the main servers.

The ministry should consider installing larger UPS units in locations where there are 10 or more computers installed in close proximity to one another. A 3 KVA unit which could support 10 computers through a power outage for more than 20 minutes can be purchased for about 3750.00 US\$. A 5 KVA unit can be purchased for about 5000.00 US\$ and could support 20 computers. The installation would require some additional cost for connecting to the power system and for running the outlets to the computer locations. There would not be a price savings over purchasing individual 650 VA units at 300.00 US\$ apiece, but the MoE would have fewer UPSs to service and fewer batteries to replace. The outlets for the computers could also be specialized so that kettles or other high draw equipment would not plug into the power meant for the computer equipment. The training room in the MoE headquarters where there are 21 workstations would be ideal for a larger UPS installation.

3.4.4 ISA SERVER

The ISA server should be moved to the same network segment as the router and firewall that is providing access to the Internet. The MoE can use the caching available with the ISA services to improve Internet access as well as monitor the web sites visited. Moving the server will reduce traffic through the server room network segment, improving performance.

Once the ministry implements a web presence or an intranet, the server should be placed in a demilitarized zone (DMZ) to isolate it from the rest of the network. A web presence would require the server to be accessible by others outside the network. The DMZ would allow access to the server, but would reduce the exposure of the rest of the network to unauthorized users.

3.4.5 ANTIVIRUS

The assessment team recommends that the MoE scan the network for computers that do not have antivirus protection installed. An antivirus solution has not been implemented on every computer connected to the network. This compromises the integrity of the network and exposes the ministry to a potential system failure. The Symantec Corporate Edition AntiVirus used by the MoE can scan the network for computers without an antivirus protection. The software will detect all major virus-scanning products from Symantec, McAfee, Trend Micro, and others. It can also block network access to those computers that do not have virus-scanning software. The scan should be run monthly to locate and rectify any deficiencies encountered.

3.4.6 MONITORING

The network infrastructure needs to be monitored on a weekly basis. The system administrator should do the monitoring on in the absence of system administrator, by an automated network-monitoring tool. Some of the logs that should be monitored on a regular basis are:

- Windows Server event logs; application, system, and security logs
- Virus scanning logs
- Virus definition and engine update logs
- Backup logs (daily)
- Web access logs
- Exchange server logs
- SQL server logs
- UPS battery capacity

Searches for updates and security patches recommended by Microsoft should be undertaken on a weekly basis and these should be installed as required.

3.5 HUMAN RESOURCES

The MoE must develop support contracts with outside sources to manage and maintain its IT infrastructure. The development of the resources within the organization, especially for system administration, is not realistic under the current environment. The contract should provide for troubleshooting, preventative maintenance, system upgrades,

and installation of patches. It should also include the remote monitoring of the systems for the detection of problems or issues.

The contract would provide for site visits on a regular basis to perform the preventative maintenance procedures and include a level of service agreement. In the absence of an on-site system administrator, the contract for the ministry's headquarters should include a minimum of two four-hour site visits per month and include monitoring and other telephone support. The contract would be in the order of 500 US\$ per month. This is the cost of the pre-paid hours the ministry is currently purchasing from ASC.

The current administrator should be documenting the system administration procedures to allow others to support the network. These documents should include:

- Cable installation information
- Equipment lists
- Software configurations
- Network resources
- Network addressing
- User administration procedures
- Policies and procedures
- Software licenses

The administrator should be recording the hardware and software changes and the troubleshooting history in a logbook. He should also be putting in place the tools necessary to monitor the systems. These tools should monitor the results of backups, event logs, network connectivity, and other items listed in the infrastructure section of this report. Alert levels should be established and a monitoring tool should notify personnel within the MoE and the contractor if an alert level has been reached. The tools can often be configured to send notifications by e-mail, pager, SMS or other methods. Big Brother is free monitoring tool that is worth reviewing, available at the URL www.bb4.com.

The MoE will also require personnel on-site full time to resolve connectivity issues, perform minor repairs, ensure the proper backup procedures are followed, and other similar items. The ministry may choose to source this person internally or contract it out as DANIDA is doing at the TED and CDC.

The assessment team recommends that the training of users in computer basic skills should continue and be expanded to include more MoE employees. The training is currently directed towards the provinces and districts that are about to obtain new computer systems. The program should also include other users within the MoE who need to acquire or upgrade their skills. The University of Zambia has offered to exchange teaching hours for the use of the teaching centre for some of its own courses. This significantly cuts the cost of delivering the courses. The courses should be designed to teach computer skills and direct the users on how the computer could be integrated into their workday.

3.6 EXAMINATIONS COUNCIL OF ZAMBIA

The ECZ should review the option of contracting some of the system administration positions to an external IT source. The lack of system administration personnel is a

serious problem for the IT department of the ECZ. It increases the chances of a disaster through poor monitoring and maintenance and also increases the chances that recovery will be difficult if not impossible. As with other parts of the ministry, this will continue to be a problem with the disparity in salaries between the private and public sector. New employees cannot be hired into the positions and internal employees that have been trained will continue to leave for more lucrative positions elsewhere. For this to be effective, the ECZ will also have to have written policies and procedures for the contractors to follow and will have to implement monitoring software that will notify the contractors of problems or issues.

The assessment team recommends that the Informix Data Server for the SCO UNIX server be purchased to provide a viable disaster recovery option for the current NCR systems. These machines are of an age where the possibility of finding spare parts to replace faulty equipment is poor. The ECZ does have two servers and one server can provide spare parts for the other to keep the department running. Should a disaster occur and both machines become disabled, the ECZ has a very limited disaster plan available. The assistant director has obtained a free copy of the Informix Data Server for SCO UNIX. This Data Server can be installed on the HP Netserver running SCO UNIX and the examination database restored on that server. The free Informix Data Server limits access to the database to 5 users concurrently. The ECZ currently requires 49 concurrent users to access the database. The free Data Server will make the ECZ operational but in a limited capacity.

The license cost for the required SCO UNIX Data Server software would be 7000 US\$. A support contract is available for an additional 3000 US\$ per year, but the team and the Assistant Director of IT at the ECZ feels that this is not required. The ECZ has not required assistance with the Informix database for over six years and the department has already successfully tested the conversion of the database to the SCO UNIX version.

The ECZ should also consider moving the database onto the SCO UNIX server once this new license has been purchased. The increased performance of the disk access on the HP NetServer should improve the performance of the database. The HP Netserver also supports a RAID 5 disk array which, when used with a minimum of five drives, greatly improves disk throughput.

3.7 TEACHER EDUCATION DEPARTMENT AND CURRICULUM DEVELOPMENT CENTRE

The Windows 2000 server should be placed in a secure air-conditioned environment with an independent power supply. It should be supplied with its own backup hardware and software and a sufficient supply of tapes to provide a proper tape rotation schedule. A complete backup solution can be purchased for less than 2000 US\$.

All the hubs should be replaced with switches to localize network traffic. If resources are limited, the most benefit could be realized by first replacing the hub that connects the TED and CDC to the WAN.

The support for the TED and CDC departments will continue to require a contract with an external supplier. The support contract should be combined with the ministry's headquarters contract and/or the ECZ contract to ensure a consistent level of support.

3.8 EDUCATION BROADCASTING SERVICE

The ministry should endeavor to implement the wireless connection between the EBS and the ministry's headquarters swiftly. The EBS will gain an immediate benefit by being able to research topics to improve the quality of the educational broadcasts and the speed with which the broadcasts can be produced.

The ministry should purchase and install a proper, tape backup system in the server at the EBS. The requirements would be similar to those required for the TED and CDC and would cost approximately 2000 US\$. A properly scheduled backup would ensure that the critical files stored on the server are being backed up on a regular basis.

The ministry should incorporate the system administration requirements of the EBS into the contract negotiated for administration of the other ministry offices. The procedures and monitoring processes created for the headquarters should be adapted and implemented at the EBS to minimize the on-site administration requirements. The consultant currently performing the administration tasks should not be required to do so as he will soon be unavailable.

4.0 REGIONAL OFFICE EXPANSION

The assessment team visited five PEOs and five DEOs both along the line of rail and in the rural areas so as to provide solutions that would take into account the wide disparities between these locales. The team created a questionnaire to assist with the investigation (see Appendix E). The questionnaire allowed the team to collect and compare information on buildings, security, power, communications, technology, and human resources at each location. This information has been compiled into Figure 6 - Site Visit Summary.

The table illustrates the disparity in the computer and communications services, human resources, and the differences in management practices at the provincial and district offices. The quantity and quality of computer equipment varies from province to province. Some provinces have telephone service available in all offices, while other provinces have no telephone service at all. Power is stable with few outages in some provinces and others have frequent outages and problems with stability. The only consistencies between the offices were the general lack of computer skills and the excellent quality of security.

Figure 6 - Site Visit Summary

| Summary of Site Visit Data for MoE Network Expansion Consultancy | | | | | | | | | | |
|--|------------------------------------|--------------------------------|---|--------------------------------------|---|---|--|--|---|----------------------------------|
| | Provinces | | | | | Districts | | | | |
| | Lusaka | Northern | Northwestern | Copperbelt | Central | Mpika | Kasama | Solwezi | Ndola | Kabwe |
| Existing Computers | 6 | 9 | 9 | 6 | 5 | 2 | 2 | 1 | 1 | 2 |
| Existing Printers | 4 | 3 | 8 | 6 | 6 | 2 | 1 | 2 | 1 | 2 |
| Local Area Network | Has a hub & cabling installed | None | None | None | None | None | None | None | None | None |
| Wide Area Network | Will be connected by 2.4 GHz Radio | None | None | None | None | None | None | None | None | None |
| Internet Access | No | Was connected but never worked | Yes through INSPRO | None | None | None | Dial-up | None | None | None |
| Telephone Access | 1 direct line | 2 direct lines | 1 fax line only | 1 direct line | 3 direct lines | 1 line but service is sporadic | Receive only | None | Receive only | 1 line |
| Monthly Avg. Phone Bill | K600000 | K2Mil | K2Mil | K5Mil | K500000 | K300000 | K500000 | K11Mil Owed | K500000 | K300000 |
| Districts with phone service | All on receive only | 0 | 0 | 2 live, 7 receive only, 1 vandalized | All 6 | N/A | N/A | N/A | N/A | N/A |
| Power - Continuity | Quite good | Load Shedding at night | Problems Often during rainy season | Quite good | Quite Good | Load Shedding plus problems in rainy season | Problems often during rainy season | Problems often during rainy season | Quite good | Quite good |
| Power - Stability | Some problems | Some problems | Some problems | No Issues | No Issues | Some problems | Some problems | Some problems | No Issues | No Issues |
| UPS's | | Most Defunct | Yes, but some quite old | Yes, but some quite old | Yes, but some quite old | Yes | Only one | One | One | Two |
| Security | No issues | No issues | No issues | No Issues | No Issues | No Issues | No Issues | No Issues | No Issues | No Issues |
| Office Space | Some ceiling leakage | No issues | leaks in some rooms but not where computers located | Large office space. | Older Building but well kept. No issues | No Issues | No leaks, but will be moving to new space soon | Have money to build a new building but are K14Mil behind in rent | Older building but only leaks in DEO's office | Older building but in good shape |
| Staff Computer Skills | | | | | | | | | | |
| No Skills | Most | Most | Few | Few | Few | Some | Some | Most | Some | Some |
| Can use mouse/windows | Some | 3 | Most minimal | Some | Most | Some | 4 | 2 | 6 | 3 |
| Install & Configure Programs | One | None | One Possibly | 1 | Some | Maybe | None | None | 1 | 1 |
| System Administration Skills | None | None | None | Same One | None | None | None | None | None | Same 1 |
| Local Resources | Many available | Little to None | Little to None | Many available | Many available | Little to None | Little to None | Little to None | Many available | Many Available |
| Applications currently used | WP | WP | WP | WP | WP | WP | WP | WP | WP | WP |
| | Excel | Excel | Excel | Excel | Excel | Excel | Excel | Excel | Excel | Excel |
| | FMS | FMS | FMS | FMS | FMS | FMS | FMS | FMS | FMS | FMS |
| | | PowerPoint | | Access | Access | | | | | |
| | | | Web Browsing | | Powerpoint | | | | | |
| Other | | | PEO has laptop | | PEO bought his own laptop | | | | | |

4.1 CURRENT ENVIRONMENT

4.1.1 INFRASTRUCTURE

The physical structures of the provincial and district offices the assessment team visited was structurally sound. The structures encountered on the assessment included:

- All four floors of a four-story office building
- One wing of an office building
- Single story buildings spread out in a compounds in areas from 300' x 300' to 150' x 50'
- Homes converted to office space

None of the buildings visited provided the team with any concerns about their ability to house computer equipment. All had areas where computers would be safe from the elements and all had locking doors and barred windows. Some sites had security guards to ensure the safety of the offices after hours. The Kasama DEO was concerned about the floor joists that are made of wood and are infested with termites.

The assessment team was informed that the PEO in Northwestern province is K14,000,000 behind in its rent and is to build itself a new building sometime in the near future. The Chivuma DEO in that province does not have a building at all and the other five districts are sharing office space with other government offices such as agriculture or health.

4.1.2 POWER

Power is available in most of the regional offices with the exception of a handful of districts such as Chavuma² in Northwestern and Mambwe³ in Eastern province. Power supply in the rural areas is often erratic during the rainy season, characterized by frequent outages and low voltages.

Most computers are connected to the power through UPSs, but many of these are of an age where the batteries are probably dead. Computers were often found connected to the same power outlets as electric kettles or other high power drawing devices. This can pose a risk of damaging the computer equipment.

4.1.3 TELECOMMUNICATIONS

Telephone service is available in all provinces and all but a few new districts. The team found that there were some provinces and many districts that did not have telephone service due to the non-payment of telephone bills. Zamtel, the telephone company had either placed the phones on receive-only or had cut them off completely. This is mainly attributable to differences in management styles of senior office management who have and enforce a strict telephone usage policy. The lack of a working telephone service will seriously inhibit the expansion of the network to these offices.

² Chavuma does not have a building and the DEO was recently evicted from the house the office was renting.

³ Without power in Mambwe district offices, the District Officer has installed the computer they were allocated at Mfuwe Airport, 27 km. from the offices.

4.1.4 COMPUTER EQUIPMENT

The computer equipment varied widely in quantity and quality between provinces. The few provinces that have been the focus of specific donor funded projects possess new, state-of-the-art computers. Other provinces have computers that are at least six years old. All of the districts visited had computer equipment that was either broken or barely usable. Most of the offices had printers that were in working condition, although a common complaint was the lack of funds to purchase toner.

None of the provinces or districts has implemented a network within their offices. This is in spite of the fact that most of the computers have network cards and many of the printers are network ready. Lusaka province has the cabling in place and a hub installed as part of the initial WAN project, but they have yet to connect the computers to the network.

Most of the provincial and district offices have computers that are Internet ready. They have a modem and an operating system capable of making a connection. Only two have attempted to do so and one was only connected for a single day before they had a problem and were not able to solve it. The other office uses the connection sporadically for e-mail.

4.1.5 HUMAN RESOURCES

The regional offices have a general lack of IT awareness. Basic computer skills such as word processing or software installation are limited. This lack of skills is more pronounced among the senior managers at both the provincial and district level. The second level managers are more aware of the benefits of IT and are more apt to try and adapt the technology.

To bridge the skills gap, the ministry's EMIS project has embarked on a nation-wide training program targeting key provincial and district personnel. This has proceeded in the Eastern and Southern provinces with limited success.

Support and maintenance are clearly major problems for the expansion of IT to the regions. Only the Central PEO and Kabwe DEO felt that they had individuals on staff who might be able to manage and maintain the computer systems. The team did not have the opportunity to assess the capabilities of these staff members. The regions outside the line of rail have few if any sources of external support or maintenance. The yellow pages of the Zambian telephone directory have less than forty listings in the entire computer category for the whole country. In Kasama, the sole source of support was a small Internet cafe with a single computer and a modem, providing word processing and other computer based services. The two individuals who ran the operation appeared to have very minimal skills. This would be typical of the type of support options available in the rural provinces. The chances of finding competent external support in Lusaka, Ndola, Kabwe, and other offices along the line of rail are significantly better.

The EMIS project has contracted a small company in Eastern province to provide support to the PEO and all the DEOs. The company's owner visits all the offices once per quarter to provide service and preventative maintenance. This service has been instrumental in keeping all systems in the province in good, working order.

5.0 REGIONAL OFFICE CONNECTIVITY OPTIONS

The ministry has many options for extending the network to the provinces and districts. Not all services are available in all areas and many of the choices are expensive to sustain. The assessment team has reviewed all the choices available for the expansion to the regional offices and they are summarized here. The choices are broken down into two major connectivity categories; private and public based networks.

5.1 PRIVATE NETWORKS

Private networks create a private communication link directly between parties through either a direct wired or wireless connection. The communications channels are not shared with others and transmission rates can be faster. The cost of private networks are greater than public networks, except where the user does not have to pay for use of the transmission media as is the case for 2.4 GHz wireless radio transmissions. The options available for private networks are:

- Dial-up
- Leased lines
- 2.4 GHz Radio Transmission
- Microwave
- Satellite

5.1.1 DIAL-UP

Connectivity between offices can be achieved through the telephone lines using modems at each location. The computers would establish a dialed-up connection through the modems and the networks at the two locations would then communicate with each other, directly. Dial-up connections are available wherever telephone service is available. The connection requires a good to high quality service for it to be useable.

The maximum speed of the connection would be less than 56 Kbps. The modems are theoretically capable of transmitting at 56 Kbps, but this is rarely achieved. Poor quality phone lines adversely affect the speed of the connection. Once connected, about 25% of the bandwidth is used for error correction. Typical data rates are 30 – 35 Kbps.

The hardware requirements of a dial-up connection are minimal. A modem at each side of the connection and a functional telephone line are all the equipment that is required. An external modem is recommended for ease of service. External modems can be purchased for approximately 100 US\$, each. Installation is simple and could be performed by the ministry employees.

Monthly charges would depend on the amount of usage each month and the toll charges from the telephone company. If the offices were connected an average of 30 hours per month (1.5 hours per workday), the toll charges would range from K120,000 (25 US\$) for local connections to K2,160,000 (450 US\$) for the farthest in-country connections. The slow connection speed and the high monthly charges eliminate private dial-up connections as an option for the ministry's needs.

Figure 7 below, summarizes the private dial-up connection attributes with a maximum usage of 30 hours connect time per month.

Figure 7 - Attributes of Private Dial-up Connection

| Availability | Speed | Fixed Costs | Monthly Costs |
|-------------------|----------|--------------------|---------------------------|
| Almost everywhere | >35 Kbps | \$200 ¹ | \$24 – \$450 ¹ |

¹ Prices in US\$

5.1.2 LEASED LINES

Zamtel offers the option of leasing a direct and dedicated full time connection between any two offices at a fixed monthly cost. Leased lines are available in both analog and digital connections. The availability of these lines is dependant on the distance of the office from the telephone central office and the quality of the phone lines. Analog lines are available in most major cities while digital connections are only available in the developed areas along the line of rail.

Analog service is limited to 56 Kbps, as is dial-up, but the throughput is higher because less of the bandwidth is used for error checking. A digital connection starts at 64 Kbps and can go up to 1.544 Mbps if Zamtel offers a T1 service. Hardware requirements include a DSU/CSU (leased line modem) and a router at each end. These can be purchased as a single unit. 3Com offers the 3Com Router 3012 (Product # 3C13612) that is a router with a built in modem and offers services for leased lines. It typically sells for 700 US\$.

Monthly rates also vary based on the distance between the two connections. The local loop between Zamtel and the local connection has a fixed charge of 100 US\$ and then an additional charge based on the distance between the exchanges. For example, a connection between Lusaka and Ndola would be 200 US\$ for the two local loops plus an additional charge of 570 US\$ for the transmission between the exchanges. These charges would be for a digital 64Kbps connection. The total monthly charge would be 770 US\$. The connection is open at all times and there are no additional charges for usage. Installation costs would be approximately 250 US\$.

The monthly cost of leased lines between the provinces and the ministry's headquarters excludes this from being a viable choice for the ministry's expansion plans. Figure 8 depicts the summary of the leased line attributes for a representative connection between Lusaka and Ndola.

Figure 8 - Attributes of Leased Line Connection

| Availability | Speed | Fixed Costs | Monthly Costs |
|--------------|--------------|---------------------|--------------------|
| Most PEOs | 56 – 64 Kbps | \$1650 ¹ | \$770 ¹ |

¹ Prices in US\$

5.1.3 WIRELESS 2.4 GHZ RADIO TRANSMISSION

Connectivity via 2.4 GHz radio transmission is freely available anywhere within Zambia. The two connections must be within 50 km. of each other and the antennas must be visible to each other. This limits the possibilities for the MoE, but it is viable for the

Lusaka PEO. It is also an option for some districts to connect with their local PEOs. In some built-up areas, the 2.4 GHz frequency can be congested with other users, which can limit its use in these areas. The speed of transmission is 12 Mbps although congestion and distance can affect the speed. Twelve Mbps speed can easily support the networking requirements of the ministry.

The fixed costs for this connection is the cost of the radios, antennas, cabling, antenna masts, and the routers that are required at each end. Figure 9 shows the estimated cost of these items.

Figure 9 - Equipment Costs for 2.4 GHz Radio Connections

| Description | Price (US\$) |
|-------------------------------------|---------------|
| Alvarion (formerly Breezecom) radio | \$2000 |
| Antenna | \$100 |
| Antenna Cable | \$50 |
| In-line surge arrestor | \$75 |
| Antenna Mast | \$600 |
| Cisco 1700 series Router | \$1000 |
| Installation | \$1000 |
| Total | \$4825 |

There would be no monthly charges. The lack of monthly charges along with the high transmission rates make 2.4 GHz radio transmission a highly recommended option. The summary of its attributes is listed in figure 10 below.

Figure 10- Attributes of 2.4 GHz Private Connections

| Availability | Speed | Fixed Costs | Monthly Costs |
|----------------------------------|---------|---------------------|------------------|
| Sites within 50 Km of each other | 10 Mbps | \$9650 ¹ | \$0 ¹ |

¹ Prices in US\$

5.1.4 MICROWAVE/SATELLITE

Private connections using microwave or satellite are not viable options. The use of microwave would involve installing and maintaining the ministry's own microwave towers which is far beyond the ministry's budgetary constraints and human resource capability. Private satellite connectivity is also prohibitively expensive.

5.2 PUBLIC NETWORKS

Public based networks share their data paths with other users, typically using the Internet through an Internet service provider. Once the remote office is connected to the Internet, the office can send e-mail or connect to and become part of the ministry's network. This would typically be done through a Virtual Private Network (VPN) connection. There are a number of method available to connect to an ISP including:

- Dial-up
- Digital Subscriber Lines (DSL)
- Wireless Internet: 2.4 GHz Radio Transmissions
- Satellite

5.2.1 DIAL-UP

Dial-up is the simplest and least expensive of the methods to connect to the Internet. The service is available in all areas of Zambia that have telephone service with reasonable quality lines. The service requires operational phone lines, which is an issue in many provincial and district offices.

The connection speed is limited to 56 Kbps and 25% of the bandwidth is used for error checking. The speed depends on the quality of the phone lines. Speeds of 30 to 35 Kbps are typical.

The fixed cost of the access would be the cost of a modem for the remote location. An external modem is recommended and since the ministry is already connected to the Internet, a modem is only required for the remote office. An external modem can be purchased for 100 US\$.

3Com has a product called a 3Com OfficeConnect Dual 56K LAN Modem (Product #: 3C888-US). This product has two built in modems, a four-port hub and can act as a router for access to the Internet. It provides security to the internal LAN and allows all users to share the dial-up line to the Internet. The two modems allow for simultaneous dial-out capabilities to the Internet and dial-in access for remote support. The product retails for 300 US\$ and this type of product is recommended for offices using a dial-up connection.

Monthly fees are based on usage of the connection. The fees include the ISP's monthly support fee for access to the Internet and the cost of the telephone call to the ISP's local Point of Presence (PoP). Zamtel is currently offering local toll fees for connections to its PoPs anywhere in Zambia. The telephone charges are only K200 for 3 minutes and this makes Zamtel the most viable choice for dial-up Internet services. Other ISPs cannot offer a local telephone charge in all areas. A usage of 30 hours per month (1.5 hours per workday) would amount to K120,000 or 25 US\$. Zamtel charges an additional 20 US\$ monthly fee for a full access Internet account. Zamtel also offers an e-mail only account for 10 US\$ per month.

The dial-up connection to the Internet is the slowest of the connection options for the ministry's expansion plans, but it may be the only option that fits the budgetary constraints. It will allow limited network communications, but the increase in other forms of communications such as e-mail make it worth pursuing. The summary of the dial-up Internet attributes is shown in Figure 11below.

Figure 11 - Attributes of Dial-up Internet Connection

| Availability | Speed | Fixed Costs | Monthly Costs |
|-------------------|----------|--------------------|-------------------|
| Almost everywhere | >35 Kbps | \$100 ¹ | \$45 ¹ |

¹ Prices in US\$

5.2.2 DIGITAL SUBSCRIBER LINE (DSL)

Digital Subscriber Line uses the existing telephone line to provide high-speed “always-on” Internet access. Installation of DSL requires a DSL modem at each end of a rented copper wire telephone line between the customer and the Zamtel exchange. All ISPs have access servers or gateways installed within the Zamtel exchange, and, therefore; the rented telephone line will only be between the customer site and Zamtel exchange.

Currently DSL is available only in six towns in Zambia that have digital facilities and physical PoPs as shown in the Figure 12 below:

Figure 12 - DSL Availability

| Town | Service Provider |
|-------------|--|
| Chingola | Zamtel |
| Kitwe | Zamnet, Zamtel, CopperNet, Microlink |
| Ndola | Zamtel |
| Lusaka | Zamtel, Zamnet, CopperNet, Microlink, UUNET |
| Chipata | Zamtel |
| Choma | CopperNet |
| Livingstone | Zamnet, (Zamtel is in the process of establishing one) |

DSL in Zambia is available at either 64 or 128 Kbps. The DSL protocol assumes that all error checking is done in the hardware allowing almost the entire bandwidth to be available for data. It is significantly faster than a 56 Kbps dial-up access.

The hardware requirements include a DSL modem and a router. The Cisco 828 G.SHDSL router combines these two functions into one unit and provides security and built-in VPN functionality. The cost of a Cisco 828 is approximately 750 US\$. One of these is needed for each side of the connection. The MoE would have to provide the router on the ISP side of the connection. Installation of the service would be 250 US\$.

Zamtel charges 100 US\$ monthly for the local loop to its exchange and the ISPs have a charge for the Internet usage based on bandwidth. The charge from Zamtel for a 64 Kbps connection is 350 US\$ per month.

A DSL connection is the least expensive of the high-speed Internet connectivity options. The service may still be too expensive for the ministry to implement at the provinces, but it would be the service recommended as having the greatest bandwidth, least cost, and being the most stable. The attributes of this service are summarized in figure 13 below.

Figure 13 - Attributes of DSL Internet Connection

| Availability | Speed | Fixed Costs | Monthly Costs |
|-----------------------------|---------|---------------------|--------------------|
| Only 6 cities within Zambia | 64 Kbps | \$1500 ¹ | \$450 ¹ |

¹ Prices in US\$

5.2.3 WIRELESS INTERNET: 2.4 GHZ RADIO

ISPs in Zambia offer Internet service to their subscribers over the 2.4 GHz radio band. The subscribers must install an antenna that has a clear view of the antenna at the ISP's radio base station. This service is only available to the MoE in Kabwe, Ndola, Chipata, Lusaka, and Livingstone.

Wireless Internet is an always-on service and is typically provided at 64 or 128 Kbps. Faster speeds up to 10 Mbps can be obtained, but with much higher monthly charges. The fixed costs of the Wireless Internet, 2.4 GHz radio connection on the customer side, are the same as for the private 2.4 GHz radio connections. The ISP would presumably already have an antenna mast and router. This would reduce both the hardware and installation costs. Figure 14 shows a breakdown of the fixed costs for this connection.

Figure 14 - Equipment Costs for 2.4 GHz Radio Internet Connections

| Description | Customer Eqpt. | ISP Eqpt |
|-------------------------------------|----------------|---------------|
| Alvarion (formerly Breezecom) radio | \$2000 | \$2000 |
| Antenna | \$100 | \$100 |
| Antenna Cable | \$50 | \$50 |
| In-line surge arrestor | \$75 | \$75 |
| Antenna Mast | \$600 | - |
| Cisco 1700 series Router | \$1000 | - |
| Installation | \$1000 | \$500 |
| Sub-Total | \$4825 | \$2725 |
| | Total | \$7550 |

The monthly charges for a 64 Kbps connection from the ISP would be approximately 700 US\$ per month; 128 Kbps would be 1400 US\$.

The same bandwidth at a lower cost is available from the ISPs using DSL connections. This option should only be considered when the DSL connection is not available or where the lines for the DSL connection are adversely affected during the rainy season. A summary of this connection's attributes is shown in figure 15.

Figure 15 -Attributes of 2.4 GHz Internet Connection

| Availability | Speed | Fixed Costs | Monthly Costs |
|--------------|---------|---------------------|--------------------|
| Very limited | 64 Kbps | \$7550 ¹ | \$700 ¹ |

¹ Prices in US\$

5.2.4 SATELLITE

Public connectivity via satellite or Very Small Aperture Terminal (VSAT) is a secure and reliable medium that uses satellite communications to connect geographically dispersed locations. Where other connectivity options are not feasible, VSAT offers two distinct advantages; less deployment time and easy manageability. VSAT uses the C or Ku band to connect to a satellite and can offer high transmission speeds. Although it is the most expensive of the connection options, pricing is not dependant upon distances and the single cost of the connection makes the cost per user go down as more users are added to the connection. Speeds can range anywhere from 64 Kbps to 45 Mbps. Higher rates can be achieved in some areas. Another advantage of VSAT is the ability to increase transmission rates as required.

To make VSAT networks affordable, it is possible to share a hub between several users, thereby spreading the cost. Each user is allocated their own time slots on carriers and

can operate their own private network using the shared hub facility without any loss of privacy. Multiple users share the bandwidth and the connectivity costs go down.

The hardware for VSAT connections includes a satellite terminal, antenna, cables, and other optional equipment. The ISP that is providing the VSAT service typically provides the equipment. CopperNet provided the team with a price of 4800 US\$ for the equipment and an installation charge of 1000 US\$. The office would also require a router to route traffic from all the internal computers to the Internet. A Cisco 1700 router would cost approximately 1200 US\$.

The cost of a shared VSAT service is dependant upon the type of service the ministry requires. A typical PEO would use a service that would support two to four computers using shared 64 or 128 Kbps multiple uplinks and a shared 4.5 Mbps downlink to a maximum speed of 128 Kbps per connection. This service limits the download capacity to 1 GB per month and would cost 520 US\$ per month.

This service is available everywhere that power is available and would be the only high-speed option available in some provinces and districts. The summary of the shared VSAT attributes is shown in figure 16.

Figure 16 - Attributes of Share VSAT Connection

| Availability | Speed | Fixed Costs | Monthly Costs |
|--------------|---------|---------------------|--------------------|
| Everywhere | 64 Kbps | \$7500 ¹ | \$520 ¹ |

¹ Prices in US\$

5.3 SUMMARY

The connectivity options for expanding the ministry WAN out to the provinces and districts are limited. The high-speed connection costs are a minimum of 450 US\$ per month per site and this may be more than the ministry's budget can afford. The dial-up connection is widely available and is affordable. Figure 17 summarizes the connections options available for the expansion to the regions.

Figure 17 - Summary of Connectivity Options

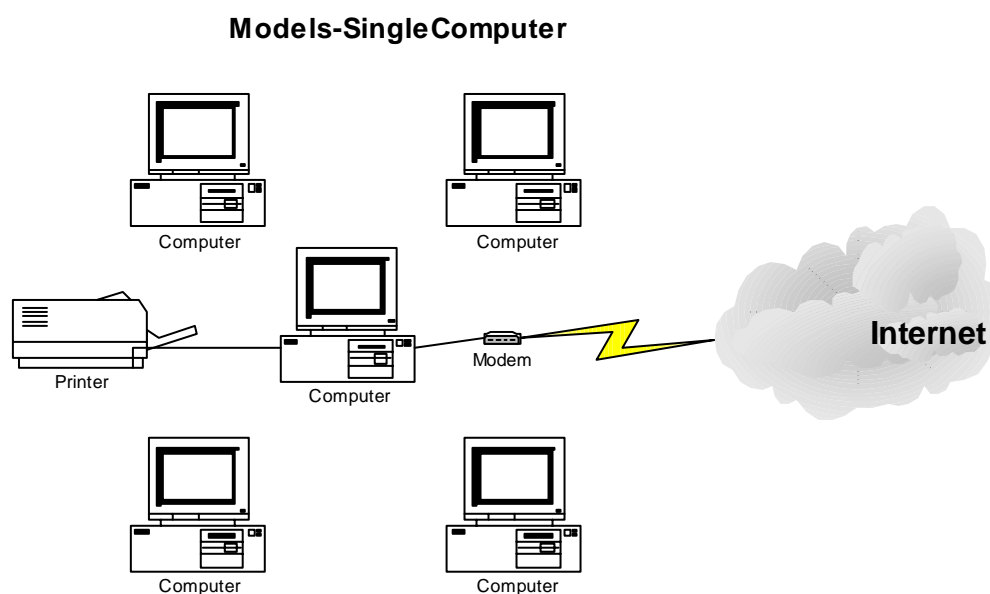
| Service | Availability | Speed | Fixed Costs | Monthly Costs |
|------------------------|----------------------------------|--------------|-------------|---------------|
| Dial-up | Almost everywhere | >35 Kbps | \$200 | \$25 – \$450 |
| Leased Line | Most PEOs | 56 – 64 Kbps | \$1650 | \$770 |
| 2.4 GHz Radio Private | Sites within 50 Km of each other | 10 Mbps | \$9650 | \$0 |
| Dial-Up Internet | Almost everywhere | >35 Kbps | \$100 | \$45 |
| DSL Internet | Only 6 cities within Zambia | 64 Kbps | \$1500 | \$450 |
| 2.4 GHz Radio Internet | Very limited | 64 Kbps | \$7550 | \$700 |
| Shared VSAT | Everywhere | 64 Kbps | \$7500 | \$520 |

6.0 REGIONAL OFFICE STRUCTURAL MODELS

There are three basic models for the provincial and district office computer systems to communicate with the MoE headquarters. The models for connection are through a single computer, through a peer-to-peer network or through a server-based network. The choice of the model is dependant upon the requirements of the remote office.

6.1 SINGLE COMPUTER

Figure 1 - Single Computer Model



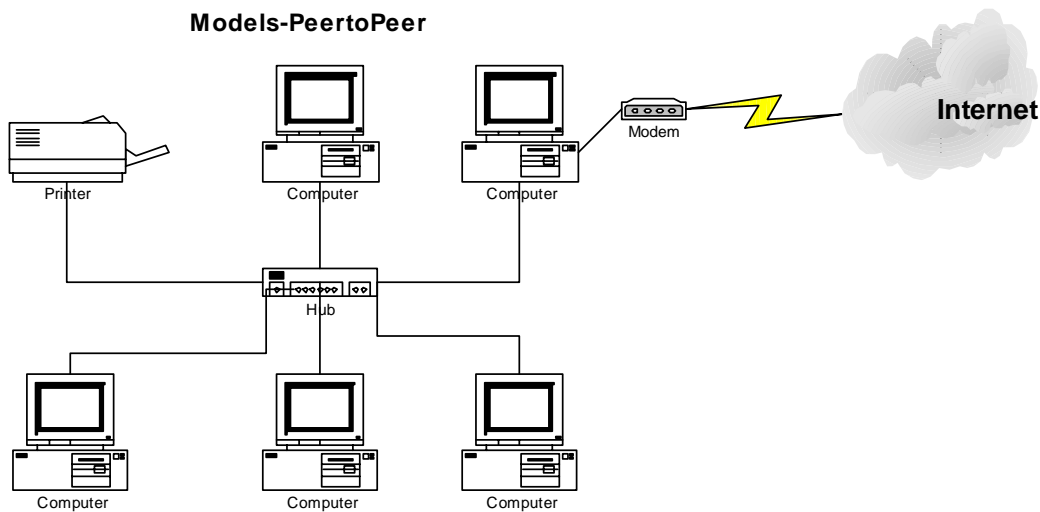
The simplest model for the remote offices is a single computer connected to the Internet. All e-mail, web browsing, and connections to the ministry's network would occur at the one computer. This model is almost immediately available at all locations. There are no requirements for cabling or other infrastructure changes. Most offices have a computer with an internal modem installed. If these offices had a working telephone line, they could be given a dial-up Internet account and access the Internet almost immediately. The costs would be 20 US\$ per month for the Internet account and K200 for every three minutes of connect time. Thirty hours per month would cost a total of 45 US\$ per month for both the Internet account and the telephone charges.

The disadvantage of the single computer model is that it does not leverage the use of resources. A network is not implemented and printers and files are not shared within the offices. All those requiring access to the Internet must share the single workstation and this could cause conflicts in larger offices. The shared computer may not provide individual users with private e-mail access. This could be offered through the use of Microsoft XP with separate user accounts.

The single computer model is not limited to dial-up access and can be implemented with any of the communications options. It is suitable for smaller offices with minimal requirements or as the first step towards another model to provide immediate access and benefits.

6.2 PEER-TO-PEER NETWORK

Figure 2 - Peer-to-Peer Model



The peer-to-peer network model is an extension of the single computer model with the addition of a LAN. The model requires the computers to be connected to each other, either through network cables or a wireless solution. The network allows for the sharing of printers, scanners, files, and other resources. The Internet is still accessed through a single computer, but that computer acts as a gateway and all other computers are granted privileges to share that connection.

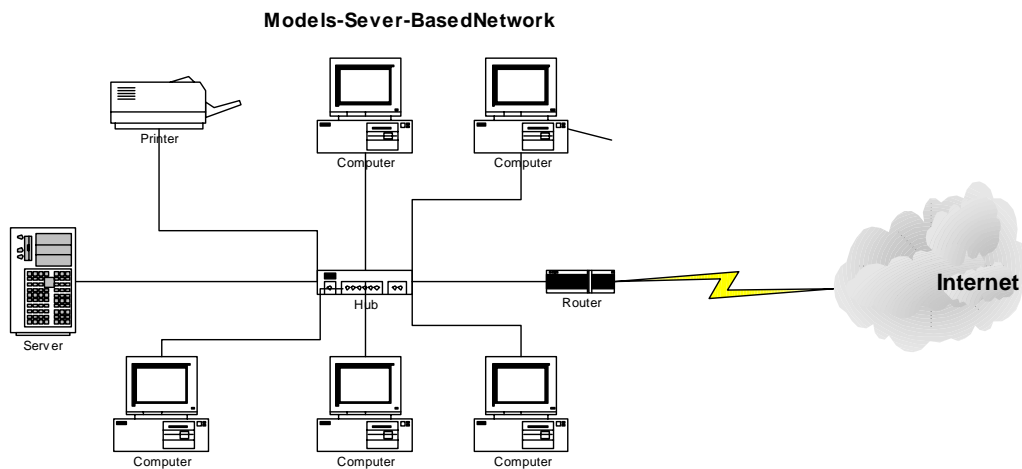
A peer-to-peer network is easy to install and configure. It does not require any additional equipment beyond a hub or a switch, network cards, and cabling. Most of the computers currently available and all of those now being purchased have network cards already installed. A wireless solution would eliminate the requirement for wiring but new network cards would have to be purchased. A site survey is highly recommended to ensure that the signal can reach all areas through the concrete structures. The network needs little administration as the individual computers control all sharing of resources.

A peer-to-peer network does not work well with more than 10 users. The lack of central control over resources can make management difficult once it starts to expand. The lack of a server also leaves the network vulnerable, as there is no monitoring of the backups. Also, every time a user accesses a shared resource, the user at the machine where the resource resides suffers reduced performance. A peer-to-peer network has no control over Internet access and connections which have charges based on usage could become unmanageable.

This model will work well in small to medium offices where Internet access needs to be shared and where users can be relied upon to back up critical data. It will work with all connectivity options. The Internet connection can be shared using a router rather than one of the computers in the network. This will have the effect of increasing costs but reducing the impact on the computer acting as the gateway.

6.3 SERVER BASED NETWORK

Figure 3 - Server Based Network



The server-based network extends the functionality of the peer-to-peer model with the addition of a server to the office network. The server provides for centralized control over resources, monitoring, and management.

The server would be located in a secure area accessible only with authorization. Access to it and the communication link to the Internet would be strictly controlled. It would provide complete control over the resources and could limit Internet usage and access on a per user basis.

If required, the server could provide only e-mail access, providing a store and forward mechanism. The server would connect to the Internet to drop off and pick up mail on a scheduled basis several times per day. The team proposes a schedule of 08:00, 10:00, 13:00, 16:00 and 20:00. This schedule allows for mail to be picked up before employees arrive for the day, drop off the mail of those who stayed after regular working hours and check for new mail several times throughout the day. Adopting this format of connection would be very inexpensive as the connection time for dropping off and picking up mail would only average a few minutes on each connection.

The server would also provide a centralized file repository for all the users. The users would use it to store all of their important files. The file directories could be monitored and produce a report on any users whose directories have not been updated with new files within a specified time period. The server could also contain a compressed (ghosted) image of a standard workstation image so the workstations could be easily rebuilt if needed.

The server would have to be configured with a tape backup unit and sufficient tapes for a proper rotation schedule. The backup software would e-mail a report of the success or failure of the backup to the internal and external system administrators. It would also report on whether the tapes are being changed as required. The server could also be configured to monitor the UPSs within the office to determine whether the equipment is being properly protected.

The users may not be able to access resources if the server fails. If this model is deployed, the service contracts should build in a level of service agreement that brings

the servers back on-line as quickly as possible. The server-based model will require more technical knowledge to administer and maintain than the peer-to-peer model and it will require more computer hardware.

The server can be built around a Linux operating system, which would allow a computer similar to that being purchased for workstations, to be used as the server. The workstation would need a tape drive and may need additional disk storage depending on the central storage requirements of the office. A Linux server can be easily managed and supported through a dial-up modem making it an ideal choice for remote offices with no administration staff.

The recommended backup software is a commercial product called LoneTar with Air Bag Disaster Recovery. It can be purchased for 470 US\$ for a single copy or can be purchased for 282 US\$ in quantities of 75. It provides a completely automated backup with verification and reports that can be e-mailed to a central location for auditing purposes. The software is able to completely restore a system from tape or DVD right from the backup media. The software allows for the creation of two diskettes which are use to boot the system and then a simple restore procedure can prepare the hard drive and restore the entire system from the backup tapes. The software also supports HP's One Button Data Recovery that allows the booting directly off of the backup tape skipping the requirement for the bootable floppies altogether.

The server-based model adds additional costs to the ministry's network expansion plans, but the additional control, security, and disaster recovery capabilities make this model worth striving for. The assessment team recommends this model for all medium to large remote offices.

6.4 SUMMARY

The standalone model can be used to get some of the remote offices that have working phone lines communicating with the ministry almost immediately. It should not be considered as the final solution for any but the smallest offices. The peer-to-peer model does provide the resource sharing capabilities that will help improve communication and the use of IT, but a server-based model should be the goal for most offices so as to provide a network that users can rely on for stability and security.

Figure 21 below provides a cost comparison of a stand alone system, a peer-to-peer system and a server-based network for the PEOs using dial-up access. More specific hardware specifications can be found in Appendix C – Equipment Specifications.

Figure 4 - Comparison of Model Costs for PEOs with Dial-up Connection

| Item Description | Price | Standalone | | Peer-to-Peer | | Server-based Network | |
|--------------------|--------|------------|---------------|--------------|----------------|----------------------|----------------|
| | | Qty | Total | Qty | Total | Qty | Total |
| Computers | \$1200 | 5 | \$6000 | 5 | \$6000 | 6 | \$7200 |
| Modem | \$100 | 1 | \$100 | 1 | \$100 | 1 | \$100 |
| Tape Backup System | \$2000 | - | | - | | 1 | \$2000 |
| Extra Disk Space | \$150 | - | | - | | 1 | \$150 |
| UPS | \$500 | 5 | \$2500 | 5 | \$2500 | 6 | \$3000 |
| Network Printer | \$1300 | 1 | \$1300 | 1 | \$1300 | 1 | \$1300 |
| Network Hub | \$500 | - | | 1 | \$500 | 1 | \$500 |
| Network Cabling | \$1500 | - | | 1 | \$1500 | 1 | \$1500 |
| Total | | | \$9900 | | \$11900 | | \$15750 |

Prices are in US\$ and are for comparison purposes. Network cabling will vary widely given the different office layouts.

7.0 NETWORK EXPANSION: RECOMMENDATIONS

7.1 NETWORK EXPANSION

The stand-alone computer model does not facilitate shared communication or resources and is not inherently scalable. It is not considered to be a viable option; however, it can be used to provide immediate connectivity for those offices that do not want to wait for an internal network to be implemented.

The MoE should provide modems to those offices that wish to implement an immediate connection. The offices must have a working telephone line. The MoE should negotiate a rate for dial-up Internet connections with Zamtel who has local PoPs for all offices. These accounts could be distributed to the offices upon request. The MoE should also approve the Internet usage policy prior to the deployment and have the senior staff member sign-off on it to protect the ministry from improper Internet usage.

The minimum recommended model for the regional offices is a peer-to-peer network with dial-up Internet access for e-mail communications only. This could be expanded to provide full Internet access if required, assuming management is able to control both telephone and Internet usage. Offices that cannot manage the use of the telephone service will only have their budgeting problems exacerbated with the introduction of full Internet access.

Regional offices with five or more computer systems should move to a server-based network model that will provide security, stability, and disaster recovery. The connectivity could remain a dial-up connection if only e-mail communication is required or if Internet browsing was required on only one or two workstations at a time. Increasing usage beyond that on a dial-up connection would make the service unusable. The MoE should strive to provide at least 64 Kbps connections in those locations. The expense of the available 64 Kbps connections in Zambia would require significant cost justifications to move the ministry to implement a 64 Kbps connection.

A summary of these options is shown in Figure 22.

Figure 5 - Recommended Network Expansion Options

| LAN Model | Communication Services | Connectivity Solutions | Estimated Monthly Communications Costs ¹ |
|----------------------|------------------------|------------------------|---|
| Peer-to-Peer Network | E-mail only | Dial-up Access | \$20 |
| Peer-to-Peer Network | Full Internet Access | Dial-up Access | \$45 |
| Server-Based Network | E-mail only | Dial-up Access | \$20 |
| Server-Based Network | Full Internet Access | Dial-up Access | \$45 |
| Server-Based Network | Full Internet Access | 64 Kbps Access | \$450-\$520 |

¹ – Costs are in US\$ and dial-up costs will vary depending upon usage.

There are several options for providing high-speed Internet connections to the provincial centres. Not all of these options are available in all provinces due to the uneven development of communications infrastructure and the distribution of PoPs in the

country. Figure 23 below provides a summary of available and recommended options for high-speed Internet connectivity in the provincial centres. There must be some justification for the increased expense of the 64 Kbps connection because of the increased cost. It is unlikely the MoE could sustain the monthly costs of the high-speed lines at all PEOs.

Figure 6 - Summary of Available and Recommended High Speed Connections for the Provinces

| PEO | Options Available | Rec. Option | Fixed Costs ¹ | Mnthly. Costs ¹ |
|--|--|------------------|--------------------------|----------------------------|
| Kabwe - Central | DSL, Wireless, Leased Line, VSAT | DSL | \$1500 | \$450 |
| Ndola – Copperbelt | DSL, Wireless, Leased Line, VSAT | DSL | \$1500 | \$450 |
| Chipata – Eastern | DSL, Wireless, Leased Line, VSAT | DSL | \$1500 | \$450 |
| Mansa – Luapula | VSAT | VSAT | \$7500 | \$520 |
| Lusaka – Lusaka | Private wireless, DSL, Wireless, Leased Line, VSAT | Private Wireless | \$9650 | 0 |
| Kasama – Northern | VSAT | VSAT | \$7500 | \$520 |
| Solwezi – North-Western | VSAT | VSAT | \$7500 | \$520 |
| Livingstone – Southern | DSL, Wireless, Leased Line, VSAT | DSL | \$1500 | \$450 |
| Mongu - Western | VSAT | VSAT | \$7500 | \$520 |
| Total Cost | | | \$45650 | \$3880 |
| Annual Cost if All Provinces High Speed | | | | \$46560 |

1 – Costs are in US\$

It is recommended that the MoE headquarters, Kabwe, Ndola, Chipata, and Livingston use DSL for high speed Internet connectivity. The MoE needs to investigate the effect the rainy season has on DSL lines near the PEOs in Chipata and Livingstone. The assessment team did not visit these locations and do not have the data on the stability of the DSL lines. Should the lines prove unacceptable, the recommendation would be a Wireless Internet, 2.4 GHz radio link.

It is recommended that the ministry continue with its plans to connect the Lusaka PEO to the ministry with a direct 2.4 GHz radio link, as this incurs no monthly charges.

In the rural provincial centres, Kasama, Mansa, Solwezi, and Mongu, the only available option for high speed Internet access is via Shared VSAT.

7.2 HUMAN RESOURCES AND CAPACITY DEVELOPMENT

7.2.1 TRAINING OF REGIONAL OFFICE PERSONNEL

The lack of IT awareness at regional offices must be addressed through training. The training provided by the EMIS project must continue to be delivered to the regional offices managers. The managers must be given training in the functions of e-mail, word processing, and spreadsheets, as well as how these tools can enhance the productivity of

their personnel. The training should also include preventative maintenance. Procedures such as shutting down computers and disconnecting them from the power source during rainstorms will go a long way in preserving the value of existing computer resources.

7.2.2 EXPANSION OF TRAINING THROUGH THE TEACHERS' TRAINING COLLEGES

The curriculum for the training programs should be made available to the Teachers' Training Colleges and the Teachers' Resource Centres. The colleges in particular have the computer resources and the teaching staff available to provide training for the regional office employees on an ongoing basis. The principal of the training college in Solwezi was keen to provide this service. He pointed out that the college has facilities to billet and feed employees during training, if the training occurred between semesters. The MoE could benefit greatly by building on these existing resources at minimal costs.

7.2.3 EXTERNAL SUPPORT CONTRACTS

The lack of personnel to support the systems in the regional offices must be addressed prior to a full-scale deployment of the network. The ministry must develop a service level agreement to monitor and support the systems in all the regions similar to the program currently in place in the Eastern region. The contract for the Eastern region costs 1000 US\$ per quarter to support the PEO and the seven DEOs. Assuming a similar contract can be arranged for the other seven provinces (excluding Lusaka who should be incorporated into the contract for the MoE headquarters), the contracted support costs for the regional offices would be 8000 US\$ per quarter or 32,000 US\$ per year. The total price for the system administration support contracts for all nine regional offices, the MoE headquarters, the EBS, CDC, and TED should amount to no more than \$50,000 US\$ per year. New installations, major problem resolution, and other items outside the scope of the contracts would increase the total support costs.

7.3 TELECOMMUNICATIONS

7.3.1 TELEPHONE USAGE POLICY

The regional managers must be encouraged to implement and enforce a telephone policy to keep their lines of communication working. A working telephone line is a key component for the network expansion at most of the regional offices. Disconnected telephone service due to non-payment of accounts will jeopardize the success of the network expansion. This is a resource management issue that is not being addressed properly by the senior management in these offices. The offices that have a strict and enforced telephone usage policy have working telephone lines.

7.3.2 ZAMTEL E-RATE

Zamtel's Managing Director has expressed the organization's willingness to consider an e-rate for telephone and Internet services should the ministry wish to propose one. The ministry should embark on discussions with Zamtel to detail the specifics of reduced rates for educational institutions. An excellent starting point would be for a bulk rate on dial-up Internet accounts that will be required for the provincial and DEOs.

7.3.3 HP DIGITAL SENDER

An HP Digital Sender should be considered for offices with high volumes of fax transmissions using long distance telephone connections. The HP Digital Sender scans in documents and then sends them to an e-mail address that is either stored in a pre-programmed key or typed in on the keypad. A message can be added to the e-mail's subject line. The document is automatically converted to PDF format and then sent as an attachment. Since the sender uses e-mail, the transmission does not incur any long distance charges. The sender can also send the document to any network capable HP LaserJet printer, acting as a photocopier or to a PC acting as a scanner. The HP9100C Digital Sender lists for 2999 US\$ in the continental US.

7.4 COLLABORATION

7.4.1 WITH OTHER DEPARTMENTS

There are many areas where the PEO, the DEO, the Teacher Resource Centre, the Teachers' College and schools are all within a few kilometers of each other. The MoE should pursue the idea of installing high-speed Internet access at a central location and sharing the access through wireless connectivity. All of these centres would benefit greatly and the connection costs could be shared to reduce the costs for all. The fixed cost for each site to share the access would be less than 5000 US\$ for the 2.4 GHz radio link. The fixed cost for the Internet access would vary by the type of service available from 1500 US\$ for a DSL connection to 7500 US\$ for Shared VSAT. The ongoing monthly charges would be 450 US\$ to 520 US\$ also varying by the type of connection.

7.4.2 WITH OTHER MINISTRIES

The Ministries of Education, Health, and Agriculture are the leading government institutions in deploying IT at the provincial and district level. Many of the ministries are sharing offices in the same building with each other and this offers the opportunity for collaboration. Sharing Internet access, support contracts and training resources offers savings to all parties participating in the collaboration.

7.4.3 WITH BUSINESS AND CIVIL SOCIETY

To successfully deploy IT and to effectively support the administration of education in the country will require the participation and assistance of other stakeholders in the public, private, and civil society. The MoE should actively engage corporate organizations, such as Zamtel and other services providers. It should also work with civil society organizations such as SchoolNet Zambia, which are working toward providing networks in schools. These organizations can assist the MoE in various ways to accelerate the effective adoption and diffusion of IT in education through voluntary contributions and strategic partnerships.

8.0 VOICE OVER IP (VOIP)

The assessment team was requested to review options to provide voice communications over the proposed WAN. Most telephone usage in the ministry is intra-office communications. If the ministry can use the wide area data network to route long distance calls between offices, the MoE could save thousands of dollars annually.

Voice over IP uses a packet switching method to transmit voice packets along the same paths that are used for transmitting data. Voice transmissions are converted from analog signals to digital, compressed, converted to packets, and then routed through the network to their destination. At the receiving end, the packets are combined into a single stream, uncompressed and converted back into an analog signal. The device that bridges the voice network and the data network together is called a Voice over IP (VOIP) gateway. A VOIP gateway merges voice and fax from telephones onto the IP network and then uses another VOIP gateway at the remote end to separate the voice or fax from the data network and send it back to the PBX, telephone or fax machine.

Voice quality is affected by a number of factors: WAN bandwidth, voice compression, and network conditions including latency, jitter, and packet loss. A normal voice call, uncompressed requires approximately 64 Kbps for a clear transmission. Callers are silent for nearly 60 percent of a call and with voice compression, only 14 Kbps per call is needed. This includes the compressed voice packet and the IP header overhead. The MoE would have enough bandwidth for VOIP with the higher speed 64 Kbps connections.

Latency is the average time it takes for a packet to pass through the network from the source to the destination. The average time varies according to the amount of traffic being transmitted and the bandwidth available at that given moment. Latency will cause a lag in the voice transmission that results in confusion as to whether a user is free to talk. This is often experienced with cellular telephone transmissions in Zambia and elsewhere. Latency in excess of 250 ms starts to become unacceptable for voice conversations. The latency that is prevalent in the Zambian Internet service is often well in excess of the 250 ms threshold.

Jitter is the variability in packet arrival at the destination. Voice packets must compete with data traffic, and bursts of traffic on the network can result in varied arrival times. When these packets arrive at irregular intervals, the result is a distortion in the sound that can make the speaker unintelligible. The minimal bandwidth within Zambia for Internet traffic will cause jitter to occur.

Packet loss is the percentage of undelivered packets in the data network. When data packets are lost, the receiving computer can simply request a retransmission. When voice packets are lost or arrive too late, they are simply discarded. The result is gaps in the conversation.

The MoE wide area data network has to be built incorporating the public Internet to connect with most of its offices. Many of these offices are in areas where only analog connections are available. VOIP will not work acceptably over an analog connection. Those areas that have digital connections will suffer from latency, bursts of traffic, and packet loss. This is due to the lack of capacity within the Zambian Internet services. Implementing a VOIP solution under these conditions is not recommended.

9.0 NETWORK SOFTWARE OPTIONS

9.1 OVERVIEW

The MoE has standardized on Microsoft software for almost all of its desktop operating systems, office automation tools, and server based systems. ECZ has a cluster of UNIX based systems, but all recently purchased systems have been built on the Microsoft platform. The constant upgrade and support costs of Microsoft products, the lack of stability of its operating systems, and the heavy handedness of the corporation have many system administrators looking for alternative software solutions.

The assessment team has been specifically asked to review the MoE's software options because the MoE has received a quote from Microsoft for a Microsoft Enterprise Agreement in the amount of 80,661 US\$ per year. The cost of this agreement is beyond the ministry's budget capabilities and would be a serious impediment to the sustainability of the network.

The assessment team has been asked to determine:

1. Is there a valid reason to move the ministry's computer systems onto an alternate software platform?
2. If a case can be made for the movement:
 - a. What are the options?
 - b. Does the ministry have or can it obtain the resources to implement and sustain the move?
 - c. What would be the costs and cost savings for such a move?
 - d. How would such a move be implemented?

9.2 ANALYSIS OF REASONS TO CHANGE

The MoE in Zambia has received a quotation for a Microsoft Enterprise Agreement from Microsoft. The quotation covers 250 licenses of Windows XP Professional, 250 Office Professional licenses, 250 Windows Client Access Licenses, and one Windows 2000 Server license. The quote provided to the assessment team was dated December 5, 2002 and was a three-year contract, which provided licenses, support and upgrades during that time period. The cost of this contract was 80,661 US\$ per year for three years. The purposes of the Enterprise Agreement are to:

- Provide a fixed price for the licenses of the listed Microsoft products
- Payment of the license costs over a three-year period at zero percent interest terms
- Free upgrades to the latest version of the products for the duration of the agreement
- Ease of administration of Microsoft licenses

The software licenses are discounted from retail prices and the holder of the licenses can have an additional 20 complimentary copies of the software for a training facility.

The ministry does not require this contract to sustain the current networking infrastructure. The ministry has already purchased all of the Microsoft licenses it requires at the time that it purchased the hardware from its vendors. The Compaq

workstations came with the Microsoft XP operating system pre-loaded with a valid license for the software. The license does not expire and can be used for as long as the ministry desires on that computer or even a replacement computer. The assessment team believes the Office Professional software licenses were acquired in the same manner. The Windows 2000 Server software license was also purchased with the server hardware. It was erroneously believed by some involved with the EMIS project that either the contract was required in order to keep licenses current or that it provided support for the products. This is not the true in either case. The licenses do not expire and support is not included with the contract.

The ministry may require new licenses for new systems that may be acquired for implementation in other offices, provinces or districts. In these cases, the contract prices for operating systems and the office automation software are still much higher than the prices of the same components when included with the purchase of a system. Figure 24 shows the comparison of the cost under the license versus the cost of the Original Equipment Manufacturer (OEM) cost.

Figure 7 - Contract vs. OEM Software Costs (US\$)

| Product | Contract Annual Cost | Contract Three Year Cost | OEM Cost | Cost Difference |
|-------------------------|----------------------|--------------------------|-----------------------|-----------------|
| Windows XP Professional | \$75.00 | \$225.00 | \$150.00 ¹ | \$75.00 |
| Office Professional | \$232.00 | \$696.00 | \$300.00 ¹ | \$396.00 |

1 – Purchase price in continental U.S. & Canada

The contract does not save the ministry any money on new software licenses as the licenses will be acquired with the new hardware at OEM pricing. The ability to upgrade the software to the latest version during the terms of the agreement is also not sufficient to warrant the cost. The upgrade from Windows 98 to Windows XP Professional is only 115.00 US\$, almost half of the three year contract price.

The ministry may also be eligible for Microsoft academic pricing which provides even lower costs than for the OEM products. Windows XP Professional Academic upgrade pricing is only 87.00 US\$ compared to the 115 US\$ for non-academic upgrades. Office Professional 2003 Academic is only 175 US\$ compared to 500 US\$ retail. The prices quoted here are based on software prices currently available in Canada and converted to US\$ based on an exchange rate of .70 Canadian dollars for 1 US. Dollar. Microsoft may have a different software pricing structure for International customers.

The ministry may still have reasons to investigate other software options. The only other reasonable option, Open Source software, has no licensing costs associated with it. It is more stable than Microsoft's offerings, it is not as susceptible to viruses, and can run similar applications faster on less powerful hardware. For new workstations, the ministry would realize a savings of over 450 US\$ each in the licensing fees of the operating systems and office automation products alone. With the ministry needing to acquire more than 100 additional workstations for the expansion to the provinces and districts, the savings would be over 45,000 US\$. This savings allows further review of the case for moving to Open Source software.

9.3 OPTIONS AND ADVANTAGES

Microsoft has clearly won the war for the desktop with over 90% of all desktop systems now using Microsoft Products exclusively. There are not many alternatives. The choices are limited to Apple, UNIX or Open Source products such as Linux. Apple is owned in part by Microsoft who invested \$150 million in the company in 1997. UNIX vendors such as Sun Microsystems have now moved away from the desktop and office automation systems and are focusing on the server market. The only potentially alternative is Linux.

Linux is an Open Source operating system, which has flourished in spite of Microsoft's dominance and does provide an alternative to those willing to make the effort. It is a stable, secure operating system that is widely supported and can typically run on smaller hardware platforms than a comparable Microsoft system. It offers solutions for both the desktop and the server environment and there are no licensing costs involved.

For desktop systems, Linux offers a graphical user interface (GUI) that is similar to Microsoft Windows. Users have not had difficulty moving from Windows to the Linux GUI. Linux has a number of license-free office productivity suites available to use. Currently, one of the most popular suites is Open Office. Open Office includes a word processor, a spreadsheet, presentation software, a drawing package and, a database. These packages are similar to the Microsoft packages so users should have little difficulty in migration. Ximian Evolution is an Open Source e-mail client well recognized for its ability to organize incoming mail. It is compatible with Microsoft Exchange, with the addition of an interface available for a small licensing fee. The Mozilla browser can replace Microsoft Explorer and is not a requirement for the operating system. System administrator can restrict Internet browsing to those people who require it.

For server systems, Linux's strongest attribute is its stability. It is not unusual to find systems running Linux that have been running non-stop for years. The servers can be managed through a GUI and the system administrator will become comfortable with the features afforded by Linux. The Microsoft server-based products all have at least one equivalent Linux product. A replacement for Microsoft Exchange is a product called Kolab (<http://kolab.kroupware.org/>). It provides E-Mail, Calendaring, Tasks, Notes and Contacts all stored on the server. There are several SQL based databases to replace SQL Server including PostgreSQL (<http://www.postgresql.org/>) and MySQL (<http://www.mysql.com/>). OpenLDAP is a replacement for the Microsoft's Active Directory. The Linux replacement for Microsoft's web server is called Apache and is the most widely used and respected web server available.

Although Linux does provide a GUI for ease of use, it can still be managed through a character-based interface. This allows for remote administration through low speed dial-up access. All of the public hospitals in Jamaica are using a Linux based patient administration system, supported by a vendor from Canada through dial-up access. This would be virtually impossible with a Windows based system given the quality of the telephone system in Jamaica. Similar conditions exist in Zambia and a Linux based system would allow for improved remote support capabilities.

Viruses that affect Linux desktops and servers are practically non-existent. The MoE's current virus scanning software is finding at least a half a dozen viruses on its systems every day. Linux and its opens source products do not require the purchase of upgrades as the licenses for the upgrades are covered under the same free Gnu Public License (GPL) as the original product. One additional advantage is that the requirement for higher performance hardware as the software is upgraded, is not as demanding as the requirements for upgraded Microsoft products.

Linux is an option for the ministry to consider as a replacement for the current Microsoft environment. The primary advantages for the replacement are:

- Cost savings on new software licenses and upgrades
- Increased stability of the desktops and servers requiring less maintenance
- Simplified remote support
- Improved security
- Increased performance

9.4 DISADVANTAGES

The primary obstacle for the MoE to overcome in a possible move to Linux is the sourcing or development of the technical skills required to implement and then support a Linux initiative. The overwhelmingly large Microsoft install base ensures that there are many more users who are familiar with the Microsoft environment than Linux. Zambia suffers from a shortage of expertise in Microsoft knowledge and this would be even more pronounced for Linux.

The ministry does have a pocket of UNIX knowledge at the ECZ whose servers do run SCO UNIX and NCR's version of UNIX. (Linux is based on the UNIX operating system). The Assistant Director of the IT department of the ECZ also runs a version of Linux as his desktop operating system. Unfortunately, the ECZ has many vacancies in its own system administration positions and lacks the available personnel to currently administer its own servers much less embark on a new Linux initiative.

The external providers of technical resources for the ministry's headquarters, ASC, do not have local Linux expertise. ASC's offices in Zimbabwe have personnel that are familiar with Sun's Solaris, which is a proprietary version of UNIX, and may provide a base of knowledge, but this would be extremely limited for such a large endeavor. Necor (Zambia) Ltd., located in Lusaka provides technical services to the banking industry and lists Linux as one of its core competencies along with UNIX and Windows. They have a total of seven hardware and software engineers and might provide a source of knowledge, but little else is known about the company at this time.

The University of Zambia is also providing Linux training as part of its curriculum for the Computer Science students although there are few students graduating at this time.

To implement a move to Linux, the ministry would most likely require out of country consultants to plan and coordinate the implementation. The ministry would also have to source competent individuals and train them from scratch on the fundamentals of installing and maintaining Linux servers and desktops.

Moving to an Open Source environment has other disadvantages. Applications provided with products like Open Office are not 100% compatible with the Microsoft products

and may create problems when exchanging information with others. There may be cases where a received document or spreadsheet cannot be opened or used when created with a Microsoft product from another organization. This often is caused by documents that have built-in macros or foreign objects linked into them. If the organization has a large number of active spreadsheets and complicated word processing documents with built in macros, they may have to spend time re-writing or re-programming these documents.

The choice of off the shelf software is also limited for users of Linux systems. Although there are many applications for Linux, the install base of Windows is such that there is more incentive to develop applications for the Windows-based market. For the MoE, this means that applications like the Financial Management System would have to be ported to Linux or some compromises would have to be made to adopt a Linux-based system. Ed*Assist would have to be ported to one of the available databases such as MySQL or PostgreSQL. The Sun Financials would have to be replaced or Next Technologies would have to port both the server as well as the client portion to Linux. (Next Technologies have already been giving some thought to porting their software to Linux as expressed in a conversation to Drake Warrick, the Chief of Party/Senior Technical Advisor for EMIS)

There also may be some hardware issues especially with new hardware that has just been developed. The development of Linux drivers for these new items lag behind the development of Windows drivers and may not be available for a while after they are released.

9.5 RECOMMENDATIONS

The team recommends that the ministry does not move from a Microsoft to a Linux based environment at this time because of the lack of resources and questionable cost-savings.

The primary motivation to examine a move away from Microsoft and onto a Linux based platform was the belief that Microsoft required 80,000+ US\$ for licensing and support under an Enterprise Agreement. The ministry does not require this agreement as its existing Microsoft software licenses do not expire and new licenses can be obtained at less cost than provided in the agreement.

Linux software may provide a cost savings to the MoE, as there are no associated licensing fees. It also offers increased stability and security. However, the lack of available technical resources for Linux both within the ministry and from external sources is the biggest obstacle and one that the assessment team feels the ministry would find difficulty overcoming. These resources would have to be developed internally and the cost associated with the development would negate any savings on the licensing fees.

The ministry may be able to obtain its Microsoft software licenses at no cost through an African initiative, which is currently providing free software for education in countries such as Botswana.

Since the team is not recommending the move, there is no need to review the costs or implementation plan.

The resources in the ECZ should be cultivated in order to support their existing UNIX servers and expand their knowledge to support Linux based systems as well. This would

allow the installation and support of other Linux systems, which could be easily supported through dial-up connections. The provinces and districts would be a prime candidate for such systems. The development of the resources in this manner might allow the ministry to regain support of their systems from external sources. The market for Linux administrators is more limited, especially in Zambia, and the retention by the ministry of these people would be higher. Once the ministry achieves a stable Linux knowledge base, it should review the case for Linux once again.

10.0 IMPLEMENTATION PLAN

The implementation will focus on four main components:

- (i) Policy development and dissemination
- (ii) Strengthening and optimizing existing MOE network
- (iii) Extending MOE network to the provincial and district offices
- (iv) Programme Planning, Management and Monitoring

The logic is that implementation of the strategies must lead to the fulfillment of the MOE's vision of "An improved information management environment" to enable effective policy formulation and implementation, support all levels of the decentralised education structure and ensure that the provision of "efficient administrative support services based on reliable information management systems" (MOE Strategic Plan 2000-2007).

10.1 POLICY, STRATEGY AND DISSEMINATION

10.1.1 OVERVIEW

There are three sub-components to the Policy, Strategy and Dissemination Project:

- (i) development of a national policy and strategic plan on ICT for the Education;
- (ii) dissemination of ICT policy for education and work programmes
- (iii) management and support.

The work programme will include the following activities:

- organization of ICT Steering Committee meetings;
- organization of ICT Steering Committee seminar to launch programme;
- organization of ICT for Education policy workshops;
- development of an MOE Intranet and EMIS home page;
- evaluation of tenders and award of contract for ICT policy technical assistance
- sourcing of documentation and reports relevant to ICT policy and strategy formation;
- sourcing of information to support management function at the provincial and district levels;
- translation of information into html format for home page
- production of CD-ROM containing above information in text and html format;
- production of an online ICT for education newsletter;

10.1.2 OUTPUTS

- (i) Tender for supply of ICT policy technical assistance services
- (ii) Shared vision and policy on ICT for Education in Zambia
- (iii) All ICT initiatives implemented in a coherent and coordinated manner
- (iv) MOE ICT enterprise-wide plan aligned to MOE Strategic Plan 2003-2007
- (v) Coordination with other ICT initiatives in the country
- (vi) Reports of meetings, seminar, workshops;
- (vii) Active MOE Intranet/ web site established;
- (viii) 1000 CD-ROMs distributed;
- (ix) Online Newsletter distributed;

10.2 STRENGTHENING EXISTING EMIS NETWORK

10.2.1 OVERVIEW

There are seven sub-components to the Strengthening Education Management Information System component:

- (i) development and implementation of the client-server EMIS database system
- (ii) Upgrading of hardware platform and software at MOE and ECZ
- (iii) recruitment and training of staff to fill vacant EMIS positions
- (iv) optimizing Internet connectivity;
- (v) rationalization of data collection procedures
- (vi) management and support of the system.

Activities under this component will include the following:

- preparation of standard IT administration policies and procedures
- systems analysis of the integrated education information system, including review of data collection procedures;
- identification and preparation of legislation relevant to information system and data protection;
- defining network management and usage policy
- evaluation and award of tender for extending MOE wireless WAN to Lusaka PEO and EBS department
- evaluation and award of tender for establishing Internet connectivity for provincial offices
- evaluation and award of tenders for procurement of upgrade hardware and software to enhance performance of ECZ and MOE networks
- elaboration of backup and disaster recovery strategy for MOE

10.2.2 OUTPUTS

- (i) E-mail is preferred mode of communication
- (ii) MOE Hq wireless Internet connections replaced with DSL connection over leased lines
- (iv) Tender for MOE Wireless WAN extension to Lusaka PEO and EBS department
- (v) Tested Disaster Recovery Plan implemented

- (vi) MOE enterprise-wide Systems administration procedures and backup strategy implemented
- (vii) EMIS data collection and processing system decentralized and online
- (viii) MOE network hubs replaced with switches
- (ix) All network equipment (i.e. servers, routers and switches) located in secure and controlled environments with clean power
- (x) SCO Unix Informix DataServer procured for ECZ
- (xi) Critical server and network spare parts identified and procured
- (xii) Anti-virus scanning software implemented on all MOE workstations and servers

10.3 EXTENDING MOE EMIS NETWORK

10.3.1 OVERVIEW

There are several sub-components to extending the MOE EMIS network to the Provinces:

- (i) upgrade of computers and Installation of LANs in PEOs and DEBs
- (ii) implementation of Internet connectivity;
- (iii) decentralize data collection to regional offices and schools
- (iv) establishment of computer training centre in 9 Colleges of Education
- (v) design and delivery of an ICT training and staff development programme;
- (vi) development of strategies and resources for promoting use and adoption ICT in the provinces and districts;
- (vii) management and support of the network.

The activities under this sub-component include the following tasks:

- provincial Internet Connectivity feasibility study
- setting up dial-up Internet connectivity in all provinces and districts as a pre-implementation step
- review telephone usage practices and negotiate an e-rate concession for education sector with ZAMTEL
- planning and completion of training
- selection, recruitment and training of Provincial IT Co-coordinators
- identification of certified basic ICT qualification
- workshops on certified basic ICT training
- workshops on generic software training
- feasibility study on establishment of ICT training centers in all Colleges of Education.

10.3.2 OUTPUTS

- (i) Models identified for Provincial Internet Connectivity
- (ii) All PEOs and DEBs have email access
- (iii) Server-based LANs installed at provincial offices and peer-to-peer networks at the DEBs
- (iv) Basic certifiable ICT qualification adopted
- (v) PEO and DEB staff provided with ICT training
- (vi) Telephone usage policy adopted
- (vii) Provincial ICT coordinators recruited and trained.
- (viii) Agreed work programme for IT Co-coordinators;
- (ix) Recruitment and training of provincial ICT co-coordinators
- (x) Consensus on establishment of ICT training centers in all Colleges of Education;

10.4 PROJECT MANAGEMENT

10.4.1 OVERVIEW

There are three sub-components to the Management Project:

- i. planning of programme;
- ii. reporting on programme;
- iii. management and support of programme.

During the first work programme the following activities will take place:

- establishment of expanded ICT Steering Committee;
- organization of recruitment and training of an IT Support person;
- evaluation of tenders and award of contract for purchase of equipment;
- evaluation of tenders and award of contract for ICT Support
- preparation of detailed implementation plan based on Strategic Plan and Work Programme;

10.4.2 OUTPUTS

- (i) Outsource contracts between MOE and IT Companies providing support Programme Manager
- (ii) Resource and activity plans
- (iii) Second Work Programme
- (iv) Monitoring and Progress Reports

10.5 IMPLEMENTATION MANAGEMENT AND MONITORING

The implementation of the programme will be overseen by an Steering Committee which will be representative of the different sectors and stakeholders ICT in education. The Programme will be managed by the EMIS Unit in the Planning and Information Directorate, which will be responsible for local management in accordance with MOE

procedures for decentralized implementation of educational programmes. Within the EMIS Unit, a detailed monitoring system to discover problems and intervene immediately will be established.

If the work of the Steering Committee is to have impact, it is important that the membership of this committee should reflect the different interests and actors in ICT in education. Thus it should be expanded to include representatives from the Ministry of Education (Statistical, Curriculum, and Informatics Interests), other Ministries (e.g. Telecommunications, Science and Technology interests), Local Government Teacher Training Colleges, School of Education (UNZA), PEO and DEO representative School Principals and their Representatives, Commercial Interests, as well as major donor Interests.

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APPENDIX B – ACRONYMS AND ABBREVIATIONS

| | |
|-----------|--|
| ADSL | Asymmetrical Digital Subscriber Loop |
| AED | Academy for Educational Development |
| AIR | American Institutes for Research |
| APC | American Power Corporation |
| ASC | Authorized Support & Consultancy |
| BDC | Backup Domain Controller |
| BESSIP | Basic Education Sub-Sector Investment Program |
| CDC | Curriculum Development Centre |
| DANIDA | Danish Agency for Development Assistance |
| DAT | Digital Audio Tape |
| DEO | District Education Office |
| DHCP | Dynamic Host Control Protocol |
| DMZ | Demilitarized Zone |
| DSL | Digital Subscriber Loop |
| DSU/CSU | Data Service Unit/Channel Service Unit |
| EBS | Education Broadcasting Service |
| Ed*Assist | Education Automated Statistical Information System Toolkit |
| ECZ | Examinations Council of Zambia |
| EMIS | Educational Management Information System |
| FMS | Financial Management System |
| GB | Gigabytes |
| GHz | Gigahertz |
| GUI | Graphical User Interface |
| HP | Hewlett Packard |
| ICT | Information Communication Technology |
| ISA | Internet Security and Acceleration |
| ISP | Internet Service Provider |
| IT | Information Technology |
| Kbps | Kilobytes per second |
| KVA | Kilovolt-Amps |
| LAN | Local Area Network |
| MB | Megabytes |
| Mbps | Megabits per second |
| MoE | Ministry of Education |
| NCR | National Cash Register |
| NFS | Network File System |
| OBDR | One Button Data Recovery |
| PDC | Primary Domain Controller |
| PEO | Provincial Education Office |
| PoP | Point of Presence |
| RAID | Redundant Array of Inexpensive Drives |
| SCO | Santa Cruz Operation |
| PBX | Private Branch Exchange |
| PC | Personal Computer |
| SCSI | Small Computer System Interface |
| TED | Teacher Education Department |
| TEVETA | Technical Education Vocational Entrepreneurship Training Authority |

| | |
|--------|--|
| UPS | Uninterruptible Power Supply |
| URL | Uniform Resource Locator |
| US\$ | United States Dollar |
| USAID | U.S. Agency for International Development |
| VOIP | Voice over IP |
| VPN | Virtual Private Network |
| VSAT | Very Small Aperture Terminal |
| WAN | Wide Area Network |
| Zamtel | Zambia Telecommunications Company Ltd. |
| ZECAB | Zambia Education Capacity Building Program |

APPENDIX C – EQUIPMENT SPECIFICATIONS

Desktop Computer Specifications

| | |
|---------------------------------------|--|
| Monitor | 17-inch |
| Processor | Intel® Pentium® 4 Processor 2.40 GHz |
| Memory | 128 PC2100 (266 MHz) DDR |
| Hard drive | 80GB Ultra ATA 100 (7200rpm) |
| Video/Graphics | Integrated Intel® Extreme Graphics 32MB equivalent |
| Internal Sound | Integrated Intel audio with speaker |
| Network Card | Integrated Intel® PRO/100 VM network connection |
| Floppy, Keyboard, Mouse, CD-ROM Drive | |
| Software: | Microsoft® Windows® XP Professional |
| | Microsoft® Office XP Professional |
| | Norton Antivirus 2003 |

Network Printer

| | |
|----------------------------|--|
| HP LaserJet 2300dn Printer | |
| Print speed, black | 25 pages/min |
| Duplex printing | Automatic |
| Memory, std. | 48MB |
| Connectivity, std. | IEEE bidirectional parallel port, One USB 1.1 port HP Jet Direct 615n Fast Ethernet (10/100Base-TX) Internal network printer server in EIO slot |

Linux Server Specifications

| | |
|---------------------------------------|---|
| Monitor | 17-inch |
| Processor | Intel® Pentium® II Processor 300 MHz (minimum) |
| Memory | 128 MB |
| Hard drive | 2 x 80GB Ultra ATA 100 |
| Video/Graphics | SVGA |
| Internal Sound | Not required |
| Network Card | Integrated Intel® PRO/100 VM network connection |
| SCSI Controller | Adaptec 29160 SCSI Controller |
| Floppy, Keyboard, Mouse, CD-ROM Drive | |
| Software: | Red Hat Linux 9 Lone Tar Backup with Air Bag Disaster Recovery |

| | |
|------------|---|
| Tape Drive | HP 12/24 GB SCSI Internal DAT 10 DDS 4 Tapes |
|------------|---|

Uninterruptible Power Supplies APC SmartUPS 650 with Powerchute software

Modem Equipment

| | |
|-----------------|---|
| Modem | US Robotics V.92 56K External Faxmodem MultiTech MultiModem ZDX |
| Dial-up Routing | 3Com OfficeConnect Dual 56K LAN Modem MultiTech RouteFinder Dial-up Router |

Networking Equipment

| | |
|-----------|--|
| Hubs | 3Com OfficeConnect Dual Speed Hub 5 3Com OfficeConnect Dual Speed Hub 8 3Com OfficeConnect Dual Speed Hub 16 |
| Switches | 3Com Superstack 3 Baseline 10/100 switch with 24 ports 3Com OfficeConnect 10/100 switch with 16 ports |
| Routers | Cisco 1710 Router with built-in firewall, VPN and IPSEC 3DES |
| Firewalls | Cisco Pix 506e |

xDSL Networking Equipment

| | |
|---------|--|
| Routers | CISCO 828 Router S.HDSL Router 1E, 1G.HSDSL (Cisco Routers with built-in xDSL capability) |
|---------|--|

Wireless Internet Access (to ISP base station)

| | |
|--------------|---|
| Radio modems | Breezecom (Alvarion) – Breeze Access SU |
|--------------|---|

Point-to-Point Wireless Internet Access

| | |
|--------------|--------------------------------------|
| Radio Modems | Breeze Access SU Breeze Access AU |
|--------------|--------------------------------------|

Shared VSAT Internet Access

| | |
|---------------|--|
| VSAT Terminal | iWay DW4020 terminal (1.2m parabolic antenna, 1 watt RF unit - Indoor Transmit Unit, Indoor Receive Unit, 4 x LAN Port, up to 100 feet of cable, connectors) |
|---------------|--|

APPENDIX D – SITES VISITED AND PERSONS INTERVIEWED

CopperNet

Martin Musaluke - Acting Managing Director

Examinations Council of Zambia

Mr. Paul Machona Acting Director

Mr. Moses Mwale Assistant Director - IT

Ms. Shakabanza Systems Manager

PC Consult

Evans Mwewa

USAID

Mr. Rick Henning - Education Sector Coordinator

Ms. Winnie Chilala

TED/CDC

Mrs Lungu - Head CDC

ZEBS

PEO - Lusaka Province

Mrs Mfula - PESO

Mr. Moses Musikanga - Statistician

Ministry of Education - HQ

Education Management Information System - EMIS Zambia

George Caldwell - AED

Charles Ndakala

Dr. Lawrence Musonda - Director Planning and Information

Education Broadcasting Service

Simon Richmond

Northern Province

District Education Office, Mpika

Easterday Chatepa Chishinte - Human Resources Officer

Mrs Mutambo - Headmistress Musakanya Basic School

Click and Dial Internet Cafe - Mpika

Mr. Kaira Murrah - Internet Cafe Operator

Duard Computers - Kasama

Provincial Education Office

Mr. Mwale - PEO

Mr. Mutala - PESO

Mr. Chibamba - PESO II

Ms Charity - Statistician

Mr. Bwalya

Kasama Teacher Resource Centre

Mr. Tyson Mwape - Subject Coordinator

Kasama College of Education

Mr. F. J. Kapembwa - Principal

Kasama District Education Office

Mr. Cosmas Chizongo - DEBS

Chiti School (a Private School in Kasama)

Mr. Burton Mugala- Proprietor

North-western Province

Provincial Education Office

Mr. Chitomfwa - PEO

Mr. Chikwilila - PESO

Mr. Ngandu - Senior Education Officer

Solwezi College of Education

Mr. Longa - Principal

Mr. Muyangana - Lecturer

Solwezi District Education Board

Mr. Chipuwo - DEBS

CopperBelt Province

Zamnet

James Chipulu - Regional Manager Zamnet Kitwe

Provincial Education Office

Mr. Chanda - PEO

Mrs B. Kulila - PESO

Ndola District Education Office

Mrs. Chikalekale - DEBS Designate

Mr. - DEBDS Outgoing (retiring)

Central Province

Provincial Education Office

Mr. Y.S. Mwansa - PEO

Kabwe District Education Office

Mr. R. Banda - DEBS

APPENDIX E – QUESTIONNAIRE USED ON ASSESSMENT TEAM SITE VISITS

Zambian Ministry of Education Computer Requirements Analysis

PEO Site Visit Checklist Computer Users

| | Existing | Required | Suitability |
|---------------------|----------|----------|-------------|
| PEO | | | |
| PESO | | | |
| SEO | | | |
| SO | | | |
| Data Entry Operator | | | |
| Secretaries: | | | |
| Other: | | | |
| | | | |
| | | | |

Computer Requirements

| | Existing | Required | Notes |
|---------------------|----------|----------|-------|
| Workstation | | | |
| Server | | | |
| Backup Device | | | |
| Hubs/Switches | | | |
| CD-RW | | | |
| Laser Printers | | | |
| Dot Matrix Printers | | | |
| Inkjet Printers | | | |
| Digital Cameras | | | |
| Scanners | | | |
| Digital Senders | | | |

| | | | |
|--------|--|--|--|
| Other: | | | |
|--------|--|--|--|

APPLICATIONS

| | Existing | Req'd | Notes |
|-----------------------|----------|-------|-------|
| E-mail | | | |
| Web Access | | | |
| Word Processing | | | |
| Spreadsheets | | | |
| Presentation Software | | | |
| Desktop Publishing | | | |
| Database | | | |
| Voice over IP | | | |
| Fax | | | |
| Virus Protection | | | |
| Ed*Assist | | | |
| Backup | | | |
| Other: | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Environment

Work Area

| | |
|-------------------------------------|--|
| Secured Office(s) Available? (Y/N): | |
| Required to Secure Areas: | |
| | |

| | |
|--|--|
| Server Room Available? (Y/N): | |
| Requirements to create Server Area or Area Available (Security, Power, Air Conditioning) | |
| | |

Furniture

| | Existing | Req'd | Notes |
|------------------|----------|-------|-------|
| Desks | | | |
| Chairs | | | |
| Printer stands | | | |
| Network Cabinets | | | |
| Other: | | | |

Power

Availability

- ☐ Clean Power is consistently Available
- ☐ Power suffers from occasional spikes and brown-outs
- ☐ Power suffers from multiple spikes and brown-outs daily
- ☐ Power is lost for short periods (10 min.) once or twice per month.
- ☐ Power is lost for short periods on a weekly or daily basis.
- ☐ Power is lost for long periods (> ½ hour) once or twice per month.
- ☐ Power is lost for long periods on a weekly or daily basis.

| | |
|--|--|
| Is a backup generator available on-site? (Y/N) | |
|--|--|

Details:

| | |
|--|--|
| Are Power Conditioners or UPSs being used? (Y/N) | |
|--|--|

Details: (Make, Rating, Age)

| | |
|---|--|
| Are dedicated power connections installed? (Y/N): | |
|---|--|

Details:

Structural Changes

- Holes in roof
- Doors
- Windows
- Walls/Partitions
- Security Bars
- Locks

Local Area Network

Is Network Cable (Cat5 UTP) Currently installed? (Y/N):

Details: (Required areas, installed properly or strung along floor)

Is a LAN currently in Place (Y/N):

What would be required to meet levels of service requested?

WAN Communication

Existing WAN? (Y/N):

Details:

(Lightning Arrestors?)

Options Available

- ☐ Dial-up
- ☐ Leased Lines

- ☐ Switched 56
- ☐ ADSL
- ☐ Fibre
- ☐ Microwave Link
- ☐ 2.4 GHz Radio Link
- ☐ VSAT

| | |
|--|--|
| Internet Service Providers who can provide services: | |
|--|--|

Local Resources

Local Suppliers (Parts, Consumables)

Local Computer Support

Local Network Cable Installers

Local LAN Support

Local WAN capabilities

Local Repair Centres

Local Training Centres

Local companies with computer skills

Human Resources

Identify the computer skill levels that are found within the organization:

| Computer Skill Level | One/Some/Most/All |
|----------------------|-------------------|
| None | |

| | |
|---|--|
| Can use Windows/mouse | |
| Can Install and configure programs | |
| Can resolve basic O/S issues | |
| Can replace hardware components | |
| Can determine source of hardware errors | |
| Can function as a System Administrator in a network environment | |

APPENDIX F – DRAFT MOE INTERNET AND E-MAIL POLICY



REPUBLIC OF ZAMBIA
MINISTRY OF EDUCATION
Internet and E-mail Policy

Overview

The Ministry of Education provides access to the vast information resources of the Internet to help employees work faster and smarter, and be a well-informed professional within the organization. The facilities to provide that access represent a considerable commitment of Ministry resources for telecommunications, networking, software, storage, etc. This Internet usage policy is designed to help employees understand our expectations for the use of those resources in the particular conditions of the Internet, and to help employees use those resources wisely.

While this policy sets forth explicit requirements for Internet usage below, it is best to start by describing the Ministry's Internet usage philosophy. First and foremost, the Internet for this organization is a business tool, provided to staff at significant cost. That means we expect staff to use their Internet access for work-related purposes, i.e., to communicate with colleagues, to research relevant topics and obtain useful business information. We insist that staff act honestly and appropriately on the Internet, and respect the copyrights, software licensing rules, property rights, privacy and prerogatives of others, just as staff would in any other business dealings. To be absolutely clear on this point, all existing Ministry policies apply to staff conduct on the Internet, especially (but not exclusively) those that deal with intellectual property protection, privacy, misuse of Ministry resources, sexual harassment, information and data security, and confidentiality.

Unnecessary or unauthorized Internet usage causes network and server congestion. It slows other users, takes away from work time, consumes supplies, and ties up printers and other shared resources. Unlawful Internet usage may also garner negative publicity for the Ministry and expose the organization to significant legal liabilities.

The chats, newsgroups and email of the Internet give each individual Internet user an immense and unprecedented reach to propagate Ministry messages and tell our business story. Because of that power we must take special care to maintain the clarity, consistency and integrity of this institutions ministerial image and posture. Anything any one employee writes in the course of acting for the Ministry on the Internet can be taken as representing the Ministry's corporate posture. That is why we expect staff to forgo a measure of individual freedom when they participate in chats or newsgroups on Ministry business, as outlined below.

While our direct connection to the Internet offers a cornucopia of potential benefits, it can also open the door to some significant risks to our data and systems if we do not follow appropriate security discipline. As presented in greater detail below, that may mean preventing machines with sensitive data or applications from connecting to the Internet entirely, or it may mean that certain users must be prevented from using certain Internet features like file transfers. The overriding principle is that security is to be everyone's first concern. An Internet user can be held accountable for any breaches of security or confidentiality.

Certain terms in this policy should be understood expansively to include related concepts. Ministry includes affiliates, and branches. Document covers just about any kind of file that can be read on a computer screen as if it were a printed page, including the so-called HTML files read in an Internet browser, any file meant to be accessed by a word processing or desktop publishing program or its viewer, or the files prepared for the Adobe Acrobat reader and other electronic publishing tools. Graphics includes photographs, pictures, animations, movies, or drawings. Display includes monitors, flat-panel active or passive matrix displays, monochrome LCDs, projectors, televisions and virtual-reality tools.

All employees granted Internet access with Ministry facilities will be provided with a written copy of this policy. All Internet users must sign the following statement:

"I have received a written copy of the Ministry of Education's Internet usage policy. I fully understand the terms of this policy and agree to abide by them. I realize that the Ministry's security software may record for management use the Internet address of any site that I visit and keep a record of any network activity in which I transmit or receive any kind of file. I acknowledge that any message I send or receive will be recorded and stored in an archive file for management use. I know that any violation of this policy could lead to dismissal or even criminal prosecution."

Detailed Internet Policy Provisions

A) Management and Administration

1. The Ministry has software and systems in place that can monitor and record all Internet usage. Staff should be aware that our security systems are capable of recording (for each and every user) each World Wide Web site visit, each chat, newsgroup or email message, and each file transfer into and out of our internal networks, and we reserve the right to do so at any time. No employee should have any expectation of privacy as to his or her Internet usage. Managers will review Internet activity and analyze usage patterns, and they may choose to publicize this data to assure that Ministry Internet resources are devoted to maintaining the highest levels of productivity. The Ministry reserves the right to inspect any and all files stored in private areas of our network in order to assure compliance with policy.
2. The display of any kind of sexually explicit image or document on any Ministry system is a violation of policy on sexual harassment. In addition, sexually explicit material may not be archived, stored, distributed, edited or recorded using our network or computing resources.

3. The Ministry may block access from within our networks to all sites known to be inappropriate or sexually explicit. If a staff member is connected incidentally to a site that contains sexually explicit or offensive material, they must disconnect from that site immediately, regardless of whether that site had been previously deemed acceptable by any screening or rating program.
4. The Ministry's Internet facilities and computing resources must not be used knowingly to violate the laws and regulations of the Republic of Zambia or any other nation.
5. Use of any Ministry resources for illegal activity is grounds for immediate dismissal, and the Ministry will cooperate with any legitimate law enforcement activity.
6. Any software or files downloaded via the Internet into the Ministry network become the property of the Ministry. Any such files or software may be used only in ways that are consistent with their licenses or copyrights.
7. No employee may use Ministry facilities knowingly to download or distribute pirated software or data.
8. No employee may use the Ministry's Internet facilities to deliberately propagate any virus, worm, Trojan horse, or trap-door program code.
9. No employee may use the Ministry's Internet facilities knowingly to disable or overload any computer system or network, or to circumvent any system intended to protect the privacy or security of another user.
10. Each employee using the Internet facilities of the Ministry shall identify himself or herself honestly, accurately and completely when participating in chats or newsgroups, or when setting up accounts on outside computer systems.
11. Only those employees or officials who are duly authorized to speak to the media, to analysts or in public gatherings on behalf of the Ministry may speak/write in the name of the Ministry to any newsgroup or chat room. Other employees may participate in newsgroups or chats in the course of business when relevant to their duties, but they do so as individuals speaking only for themselves. Where an individual participant is identified as an employee or agent of this Ministry, the employee must refrain from any unauthorized political advocacy and must refrain from the unauthorized endorsement or appearance of endorsement by the Ministry of any commercial product or service not sold or serviced by this Ministry, its branches or its affiliates. Only those managers and Ministry officials who are authorized to speak to the media, to analysts or in public gatherings on behalf of the Ministry may grant such authority to newsgroup or chat room participants.
12. The Ministry retains the copyright to any material posted to any forum, newsgroup, chat or World Wide Web page by any employee in the course of his or her duties.
13. Employees are reminded that chats and newsgroups are public forums where it is inappropriate to reveal confidential Ministry information, and any other material

covered by existing Ministry confidentiality policies and procedures. Employees releasing protected information via a newsgroup or chat – whether or not the release is inadvertent – will be subject to all penalties under in existing data security policies and procedures.

14. Use of Ministry Internet access facilities to commit infractions such as misuse of Ministry assets or resources, sexual harassment, unauthorized public speaking and misappropriation or theft of intellectual property are also prohibited by general Ministry policy, and will be sanctioned under the relevant provisions of the personnel handbook.

B) Technical

1. User IDs and passwords help maintain individual accountability for Internet resource usage. Any employee who obtains a password or ID for an Internet resource must keep that password confidential. Ministry policy prohibits the sharing of user IDs or passwords obtained for access to Internet sites.
2. Employees should schedule communications-intensive operations such as large file transfers, video downloads, mass emailings and the like for off-peak times (defined however that is appropriate for the particular Ministry).
3. Any file that is downloaded must be scanned for viruses before it is run or accessed.

C) Security

1. The Ministry has installed a variety of security systems to assure the safety and security of the Ministry's networks. Any employee who attempts to disable, defeat or circumvent any Ministry security facility will be subject to immediate dismissal.
2. Files containing sensitive or confidential Ministry data as defined by existing data security policy that are transferred in any way across the Internet must be encrypted.
3. Computers that use their own modems to create independent data connections sidestep our network security mechanisms. An individual computer's private connection to any outside computer can be used by an attacker to compromise any Ministry network to which that computer is attached. That is why any computer used for independent dial-up or leased-line connections to any outside computer or network must be physically isolated from Ministry's internal networks
4. Only those Internet services and functions with documented business purposes for this Ministry will be enabled at the Internet firewall.

Policy note:

Because unscrupulous or malevolent web site operators can take control of an unsuspecting visitor's computer using apparently routine JAVA or file transfer operations, such transactions can introduce material risks to network security for which there is no bullet-proof technical solution short of complete abstinence. Because of the potential risk to the network and institutional data, the Ministry network security policy requires that all FTP transactions and JAVA downloads be blocked at the outermost firewall. However, users with a specific business need for FTP or JAVA may request such access in writing from the Director of the Planning Unit. In addition FTP and JAVA will be disabled for users on networks used for running mission-critical applications or the storage and production of core business data.

Detailed E-Mail Policy Provisions**A) Purpose**

1. The purpose of e-mail is to conduct Ministry business.

B) Ownership

1. E-mail equipment and messages are Ministry property.
2. Messages that are created, sent or received using the Ministry's e-mail system are the property of the Ministry.
3. The Ministry reserves the right to access and disclose the contents of all messages created, sent or received using its e-mail system.

C) Usage

1. All e-mail communication must be handled in the same manner as a letter, fax, memo or other business communications.
2. No copyrighted or Ministry proprietary information is to be distributed by Ministry e-mail unless approval has been granted by a Ministry official
3. No commercial messages, employee solicitations, messages of a religious or political nature are to be distributed using Ministry e-mail.
4. E-mail messages may not contain content that may be considered offensive or disruptive. Offensive content includes but is not limited to obscene or harassing language or images, racial, ethnic, sexual or gender specific comments or images or other comments or images that would offend someone on the basis of their religious or political beliefs, sexual orientation, national origin or age.
5. Employees may not retrieve or read e-mail that was not sent to them unless authorized by the Ministry or by the e-mail recipient.

D) Non-Business E-mail

1. Incidental and occasional personal use of electronic mail is permitted. Such messages become the property of the Ministry and are subject to the same conditions as Ministry e-mail.

E) Violations

1. Violation of this policy will result in disciplinary action up and including termination and/or legal action if warranted.
2. Employees should report any misuse of the Ministry e-mail system or violations of this policy to the appropriate Ministry official.